Calibration Procedure Control
Log Number: DALS 0835
Entry Date: 10-31-95
Entered by: [illegible]

CHANGE/ERRATA INFORMATION

ISSUE NO: 8 6/80

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The revision letter stamped on the indicated PCB is equal to or higher than that given with each change.

2. No revision letter is indicated at the beginning of the change/errata.

MANUAL

Title: 8500A DIGITAL MULTIMETER
Print Date: JULY 1977
Rev. and Date: -----

C/E PAGE EFFECTIVITY

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ERRATA #1

Change para. 4-12, step 4 to read:
4. Open hinged module top.

NOTE

Make sure the leaf spring, attached to one half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

Change para. 4-70, step 5 to read:
5. Using a small screwdriver or similar tool, lift and positi the leaf spring, attached to one half of the module shield, that it rests firmly over the flange of the opposite half the module shield.

CHANGE #1 - 11027

On page 5-28, add the following:
Shield, relay (not shown)|469585|89536|469585|1

CHANGE #2 - 11080

On page 5-16, change reference designator C6 to read:
C6|CAP, CER, 0.047 UF +/-20%, 50V|460733|71590|CW20C473M|1

On page 8-13, in the upper right hand corner:
Delete C6 (right)
Change C6 (left) to read, under description, ".047 uF".

CHANGE #3 - 11115

On page 5-3, delete Item No. 5 and all descriptive data.

CHANGE #4 - 11193

On page 5-3:
Change Item No. 8 data to read:
8|Corner|394346|89536|394346|2

Change Item No. 9 data to read:
9|Handle|394304|89536|394304|2

CHANGE #5 - 11194

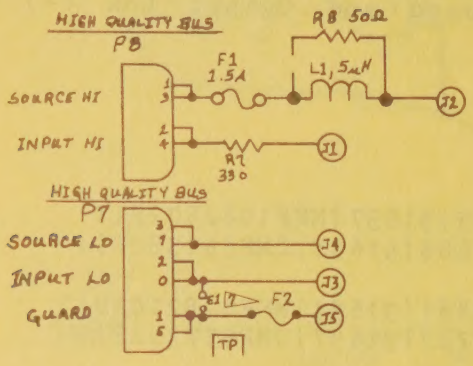
On page 5-6:
Change Item No. 5 to read:
15|Decal, corner|394387|89536|394387|4

CHANGE #6 - 11352
On page 5-16, change the Fluke Stock No. and Mfg. Part No.:
FROM: U7|428813, TO: U7|473108
FROM: U22|418442, TO: U22|473090
FROM: U25|413252, TO: U25|473074
FROM: U33|418020, TO: U33|473082

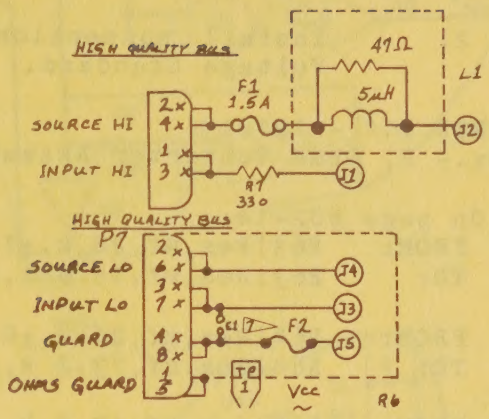
CHANGE #7 - 11471

On page 8-15, in the upper left hand corner:

FROM:



TO:



Also immediately beneath U17 and U20, add: "60 ohm (ALL)" and Beneath U29 and U30, add: "1 k (ALL)".

CHANGE #8 - 11763
Rev.- L, A2 Motherboard PCB Assembly

FROM: J41|BINDING POST, BLACK|275560|32767|820-45|
TO: J41|BINDING POST, BLACK|493981|83330|21527-102|

FROM: J42|BINDING POST, RED|275552|32767|820-65|
TO: J42|BINDING POST, RED|493973|83330|2157-103|

CHANGE #9 - 11581
Rev.- H, A7 Display PCB Assembly

On page 5-24:
FROM: Spacer|446461|11897|167-PB-0588|1
TO: Spacer|448432|89536|448432|1

CHANGE #10 - 11859
Rev.- C, A10A2 Fast RXR A/D Converter

On page 5-38:
Delete U23 from the U14 listing and change the TOT QTY, FROM:5, TO:4.
ADD: U23|IC Linear, 5-Xstr Array|477778|89536|477778|1

ERRATA #2

On page 4-4, Figure 4-1:
1. Delete connection from DC Voltage Standard Guard to Voltage Divider Input Ground.

2. Install connection between guard and Output Low (-) on DC Voltage Standard.

On page 4-5, Figure 4-3:
1. Install connection between guard and Output Low (-) On DC Voltage Standard.

On page 4-6, Figure 4-3:

1. Delete connection from DC Voltage Standard Guard to Voltage Divider Input Ground.

2. Install connection between guard and Output Low (-) on Dc Voltage Standard.

CHANGE #11 - 12101
Rev.- F, Ohms Converter Assembly

On page 602-14:

FROM: R63|Res,mf,28 k,±1%,1/8W|291835|91637|MFF1082802F|1
TO: R63|Res,mf,15.8 k,±1%,1/8W|293688|91637|CMF551582F|1

FROM: R64|Res,mf,21 k,±0.5%,1/8W|229484|91637|MFF1-82102D|1
TO: R64|Res,mf,73.2 k,±1%,1/8W|237222|91637|CMF557322F|1

FROM: R65|Res,mf,17.8 k,±1%,1/8W|349183|91637|MFF1-81782F|1
TO: R65|Res,mf,30.1 k,±1%,1/8W|168286|91637|CMF553012F|1

On page 602-16, Figure 602-5:

FROM:	R64, 28k	FROM:	R64, 21k	FROM:	R65, 17.8k
TO:	R64, 15.8k	TO:	R64, 73.2k	TO:	R65, 30.1k

CHANGE #12 - 12103
Rev.- M, A10A1 A/D Analog PCB Assembly (MIS-4140)

On page 5-32:

ADD: C22|CAP, CER, 0.22UF+/-20%, 50V|309849|71590|CW30C224K|REF
ADD: C23|CAP, CER, 0.22UF+/-20%, 50V|309849|71590|CW30C224K|REF
Change TOT QTY of C16, FROM: 2, TO: 4.

On page 5-34, Figure 5-10, and page 8-21, Figure 8-17:
Add C22 and it's symbol between C8 and R23 (just above U4).
Add C23 and it's symbol between R63 and Q6 (just below U4).

On page 8-23/8-24, Figure 8-19:
Add C22 and it's symbol between U4-6 and earth ground.
Add C23 and it's symbol between U4-4 and earth ground.

ERRATA #3

On page 4-7, para. 4-42, step 6:

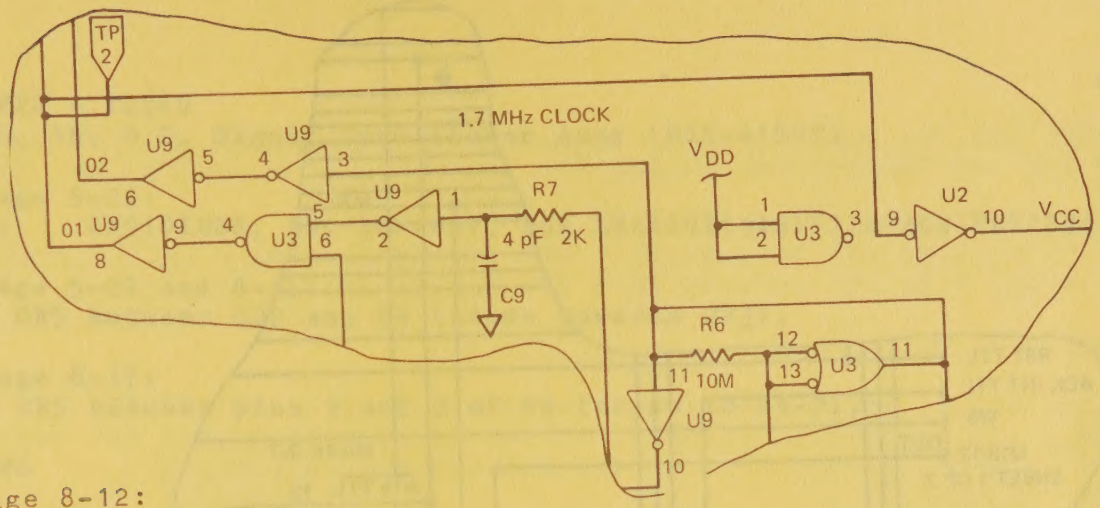
FROM: ...that the voltage between RT5 and Vss reads be-...
TO: ...that the voltage between LINE and Vss reads be-...

CHANGE #13 - 10945
Rev.- K, A10A1 A/D Analog Assembly (MIS-4140)

On page 5-36:

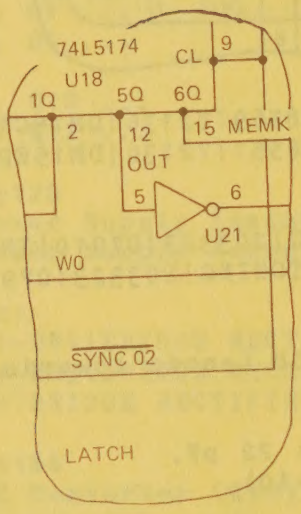
FROM: U4,U7|IC,Op-Amp,J-FET,Input|310037|12040|LH0042CH|2|1
TO: U4,U7|IC,LIN,OP-AMP,MONOLITHIC,J-FET INPUT|429837|12040|LF356F|2|1

TO:

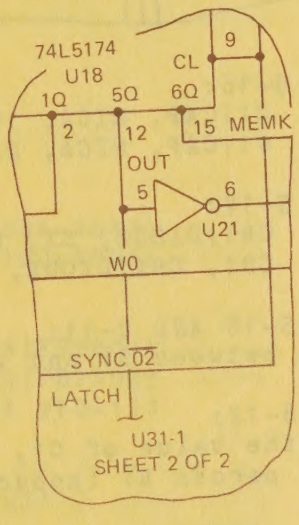


On page 8-12:

FROM:

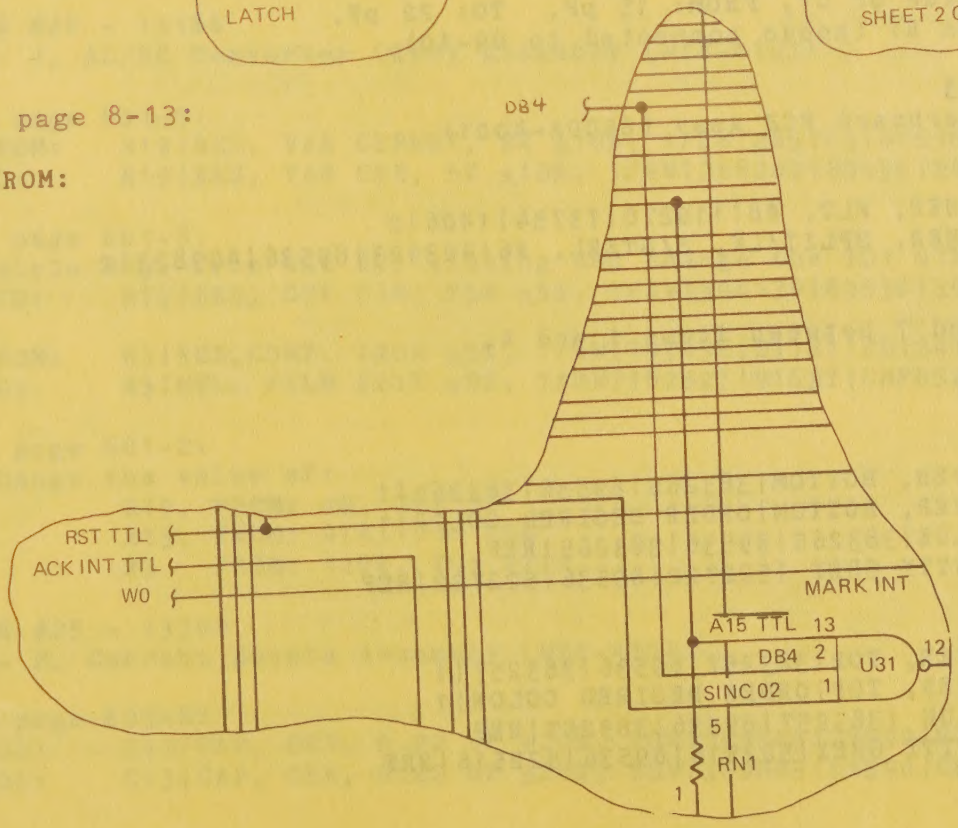


TO:

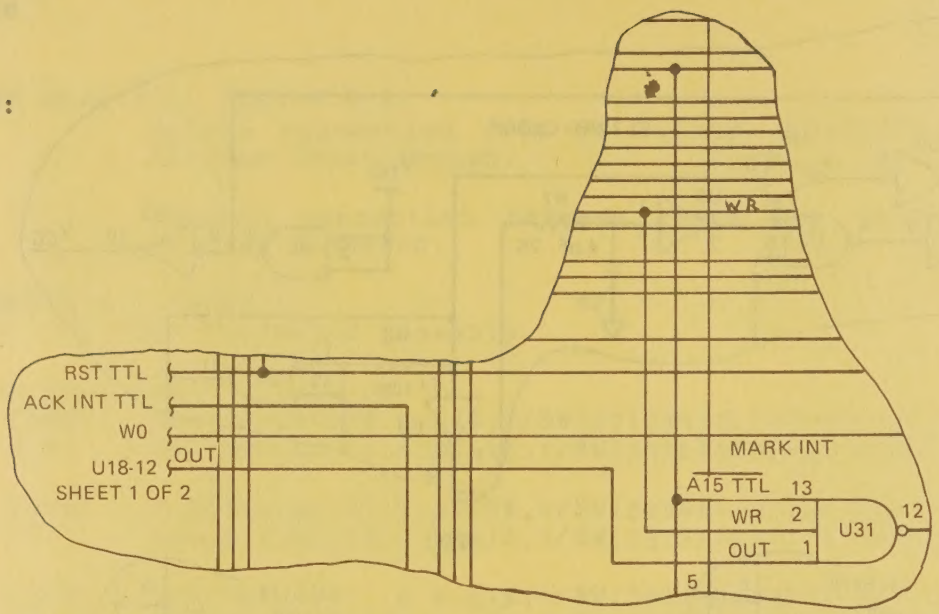


On page 8-13:

FROM:



TO:



On page 5-16:
FROM: C1|CAP, MICA, 15 PF ±5%, 500V|148569|72136|DM15C150J|1
TO: C1|CAP, MICA, 22 PF ±5%, 500V|148551|72136|DM15E220J|1

On page 5-17:
FROM: CR1|DIODE, SI, HI-SPEED SWITCHING|203323|07910|IN4448|1
TO: CR1, CR2|DIODE, SI, HI-SPEED SWITCHING|203323|07910|IN4448|2

On page 5-18 AND 8-11:
Add CR2 between R1 and the side of the PCB (anode towards TP2).

On page 8-12:
Change the value of C1, FROM: 15 pF, TO: 22 pF.
Add CR2 across R1 (anode connected to U9-10).

CHANGE #20 - 12873
Rev.- M, A2 Motherboard PCB Assy (8500A-4001)

On page 5-10:
ADD: 6|WASHER, FLT. #8|110270|73734|1406|2
ADD: 7|WASHER, SPLIT/LK, S/STEEL, #6|403923|89536|403823|2

On page 5-9:
Add items 6 and 7 between items 1 and 4.

CHANGE #21 - 12887

On page 5-3:
FROM: 10|COVER, BOTTOM|383265|89536|383265|1
TO: 10|COVER, BOTTOM|ORDER DESIRED COLOR|1
BLUE|383265|89536|383265|REF
PUTTY GREY |522722|89536|522722|REF

On page 5-6:
FROM: 12|COVER, TOP|383257|89536|383257|1
TO: 12|COVER, TOP|ORDER DESIRED COLOR|1
BLUE |383257|89536|383257|REF
PUTTY GREY|522516|89536|522516|REF

CHANGE #22 - 12960
Rev.- L, A8, D.C. Signal Conditioner Assy (MIS-4100T)

On page 5-25:
ADD: CR5|DIODE, SI, LOW-CAP, LOW LEAKAGE|348177|07263|FD7223|1

On page 5-26 and 8-16:
Add CR5 between Q22 and U4 (anode towards Q23).

On page 8-17:
Add CR5 between pins 3 and 2 of U4 (anode to U4-2).

ERRATA #6

On page 602-12:
FROM: Q2, Q4 ...
TO: Q3, Q4 ...

FROM: Q3, Q12 ...
TO: Q2, Q12 ...

CHANGE #23 - 13120
Rev.- D, A4 Power Supply Assembly, 115/230V (8500A-4041)
Rev.- B, A4 Power Supply Assembly, 100V (8500A/100-4041)

On page 5-12:
FROM: BR1-BR4|BRIDGE RECTIFIER|296509|09423|FB200|4
TO: BR1-BR3|BRIDGE RECTIFIER|296509|09423|FB200|3
TO: BR4|BRIDGE RECTIFIER|428839|04713|MDA 970-1|1

CHANGE #24 - 13166
Rev.- J, AC/DC Converter (AVG) Assembly (MIS-4101)

On page 601-9:
FROM: R19|RES, VAR CERMET, 2K ±10%, 1/2W|285163|89536|285163|1|1
TO: R19|RES, VAR CER, 5K ±10%, 1/2W|288282|89536|288282|1|1

On page 601-8:
Delete R13, from the R26 listing and change the TOT QTY, FROM: 4 TO: 3
ADD: R13|RES, DEP CAR, 75K ±5%, 1/4W|394130|89536|394130|1

FROM: R3|RES,COMP, 120K ±5%, 1/4W|193458|01121|CB1245|1
TO: R3|MTL. FILM 221K ±5%, 1/2W|182527|91637|CMF652213F|1

On page 601-2:
Change the value of:
R19, FROM: 2K, TO: 5K
R13, FROM: 47K, TO: 75K
R3 FROM: 120K, TO: 221K

CHANGE #25 - 13304
Rev.- H, Current Shunts Assembly (MIS-4104)

On page 603-8:
ADD: C12|CAP, CER, 0.22 UF ±20%, 50V|309849|71590|CW30C224K|2
ADD: C13|CAP, CER, 0.22 UF ±20%, 50V|309849|71590|CW30C224K|REF

On page 603-15:
Add C12 and C13 between U6 and C5.

On page 603-16:
Add "C12, 0.22 uF" between U6-6 and Analog ground.
Add "C13, 0.22 uF" between U6-3 and Analog ground.

ERRATA #7

On page 603-5, change the first sentence of para. 603-16:
FROM: At the second address, if the input voltage did not exceed ±45V, termination of the address clocks range ...

TO: If the input voltage did not exceed ±45 volts at the second address, termination of that address will clock range ...

On page 5-31:
Change the MFG PART NO. OR TYPE for U5,
FROM: LM1346H, TO: LM14364

On page 5-14:
Change the MFG PART NO. OR TYPE for U5,
FROM: MC7805CP, TO: F78050C

On page 5-28:
Change the MFG PART NO. OR TYPE for R64,
FROM: MFF1 - 81002F, TO: CMF551001F

On page 5-19:
Change the MFG PART NO. OR TYPE for:
U15, U16, U21, FROM: SN74LS08, TO: SN74LS08A
U8, FROM: SN74LS51, TO: SN74LS51A

On page 5-25:
Change the MFG PART NO. OR TYPE for:
C13, FROM: 33C41B6, TO: C023B101F103M

On page 617-2:
ADD: 8|MATING CONN., REAR INPUT (NOTSHOWN)|475475|89536|475475|1
|CONN., MATING|369231|89536|369231|REF
|CONN., SOLDER PINS|369298|89536|369298|REF
|CONN., CRIMP PINS|369280|89536|369280|REF

CHANGE #26 - 13403
Rev.- E, A4 Power Supply Assembly, 115/230V (8500A-4041)
Rev.- C, A4 Power Supply Assembly, 100V (8500A/100-4041)

On page 5-12:
FROM: U1, U3|IC. LIN, VOL REG.|413187|04713|MC7815CP|2|1
TO: U1|IC. LIN, VOL REG.|413187|04713|MC7815CP|1
TO: U3|IC. LIN, ADJ. VOL REG.|460410|25088|B62110-J1021-X025|1

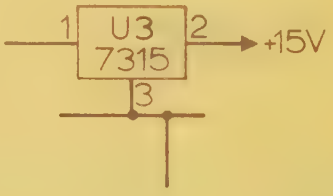
ADD: R7|RES, DEP. CAR, 240 ±5%, 1/4W|376624|80031|CR251-4-5P240ET|1
ADD: R8|RES, DEP. CAR, 2.4K ±5%, 1/4W|441493|80031|CR251-4-5P2K4|1
ADD: R9|RES, VAR, CERMET|32086|19701|ET50W-500|1

On page 4-7, add the following sentence to para. 4-42:
"4b Adjust R9 so that VA1 is within ±0.25V of |VA2|."

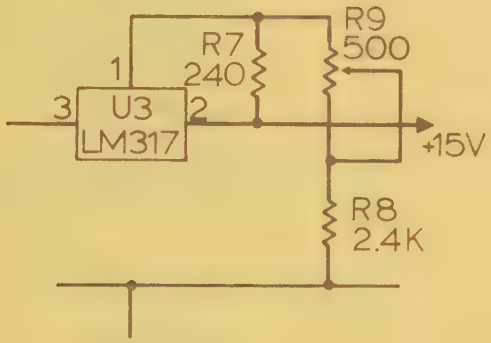
On page 5-13 and 8-8:
Add R8 and R7 between U4 and R2.
Add R9 between U4 and C17.

On page 8-9:

FROM:



TO:



CHANGE #27 - 13505

On page 5-2 add the following note to para. 5-5:

NOTE

ALL 1/4 WATT CARBON FILM RESISTORS MAY BE USED AS A DIRECT REPLACEMENT FOR 1/4 WATT CARBON COMPOSITION RESITORS OF THE SAME VALUE.

CHANGE #28 - 13517
Rev.- G, RMS Converter Assy (MIS-4103)

On page 609A-11:
FROM: CL1|DIODE, FET, CURRENT REGULATOR|285106|07910|TCR5309|1
TO: CL1|DIODE, FET, CURRENT REGULATOR|429373|89536|429373|1

CHANGE #29 - 13562
Rev.- M, A6 Controller Assy (8500A-4185T)

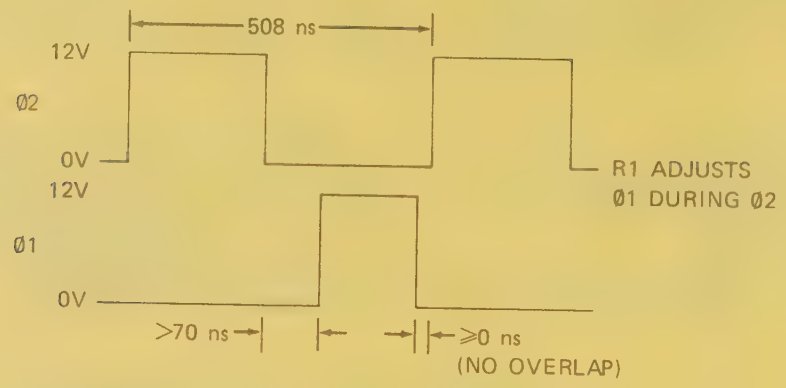
On page 5-16:
FROM: C8, C9|CAP, MICA, 4PF ±0.5PF, 500V|190397|72136|DM15C040E|2
TO: C9|CAP, MICA, 4PF ±0.5PF, 500V|190397|72136|DM15C040E|1
TO: C8|CAP, MICA, 15PF ±5%, 500V|148569|72136|DM15C150J|1

On page 8-12:
Change the value of C8, FROM: 4 pF, TO: 15 pF.

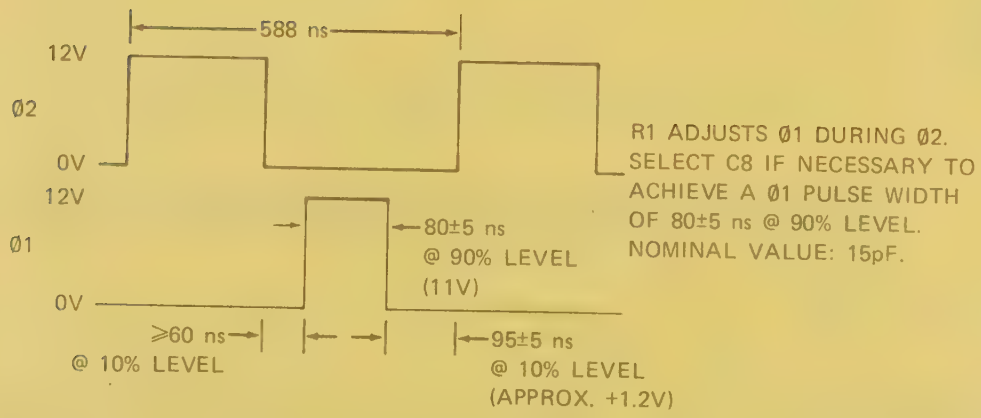
On page 4-17:

FROM:

1. Check Ø1 and Ø2 at TP2, TP3



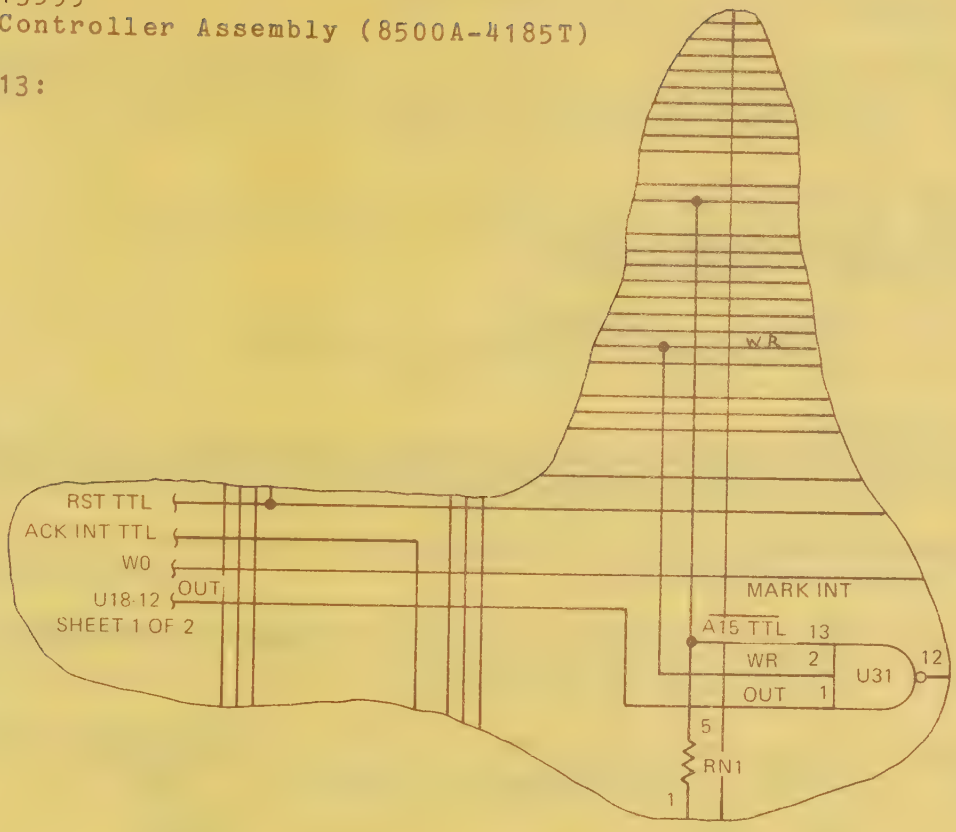
TO:



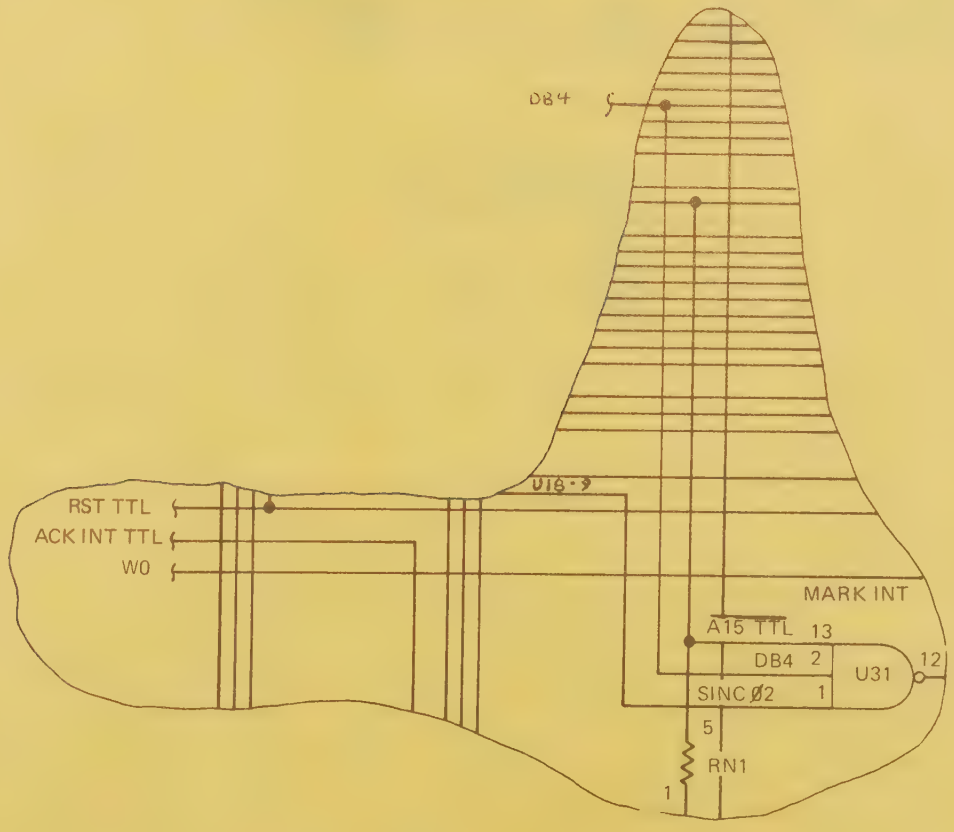
CHANGE #30 - 13599
Rev.- N, A6 Controller Assembly (8500A-4185T)

On page 8-13:

FROM:



TO:



CHANGE #31 - 13641
Rev.- P, A10A1 A/D Assembly (MIS-4140)

On page 5-35:
FROM: R25, R26|RES, MF, 49.9K ±1%, 1/8W|268821|91637|MFF1-84992F|2
TO: R25, R26|RES, MF, 42.2K ±1%, 1/8W|221655|91637|CMF554222F|2

On page 8-23/8-24:
Change the value of R25 and R26:
FROM: 49.9K
TO: 42.2K

CHANGE #32 - 13648
Rev.- E, A10A2 A/D Digital Assembly (MIS-4141)

On page 5-38:
Delete U38 from the U14 listing and change the TOT QTY, FROM: 4, TO: 3
Add U38 to the U23 listing and change that TOT QTY, FROM: 1, TO: 2

CHANGE #33 - 11353
Rev.- C, RMS Converter Assy. (MIS-4103)

On page 609A-12:
FROM: R2|RES, MTL FILM, 13K ±1%, 1/8W|335539|91637|CMF551302F|1
TO: R2|RES, MTL FILM, 16.9K ±1%, 1/8W|267146|91637|CMF551692F|1

FROM: R3|RES, MTL FILM, 2K ±1%, 1/8W|235226|91637|CMF552001F|1
TO: R3|RES, COMP, 200K ±5%, 1/2W|169839|01121|EB2015|1

On page 609A-17/609A-18:
Change the value of R2, FROM: 13K, TO:16.9K.
Change the value of R3, FROM: 2K, TO: 200 .

Change/Errata Information

Issue No: 3 10/78

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The instrument's PCB revision letter is lower than that which is indicated at the beginning of the change/errata.

2. No revision letter is indicated at the beginning of the change/errata.

MANUAL

Title: 8500A DIGITAL MULTIMETER
Print Date: JULY 1977
Rev and Date: – – –

C/E PAGE EFFECTIVITY

Page No.	Print Date
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ERRATA #1

Change paragraph 4-12, step 4 to read:

4. Open hinged module top.

NOTE

Make sure the leaf spring, attached to one half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

Change paragraph 4-70, step 5 to read:

5. Using a small screwdriver or similar tool, lift and position the leaf spring, attached to one half of the module shield, so that it rests firmly over the flange of the opposite half of the module shield.

CHANGE #1–11027

On page 5-28, add the following:

Shield, relay (not shown); 469585; 89536; 469585; 1

CHANGE #2–11080

On page 5-16, change reference designator C6 to read:

C6, Cap, cer, .047 uF; 460733; 71590; CW20C473M; 1

On page 8-13, in the upper left corner:

Delete C6 (right)
Change C6 (left) to read, under description, ".047 uF".

CHANGE #3–11115

On page 5-3, delete Item No. 5 and all descriptive data.

CHANGE #4–11193

On page 5-3, change Item No. 8 data to the following:

8 Corner, 394346, 89536, 394346, 2

Change Item No. 9 data to read:

9 Handle, 394304, 89536, 394304, 2

CHANGE #5–11194

On page 5-6, change Item No. 15 to read:

15, Decal, corner. 394387, 89536, 394387, 4

CHANGE #6–11352

On page 5-16, change Fluke Stock No. and Mfg. Part No. for the following entries:

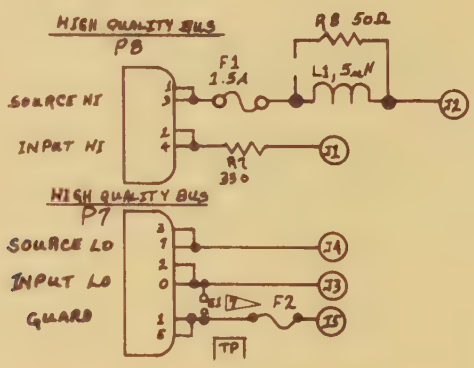
U7, from: 428813 to: 473108
U22, from: 418442 to: 473090
U25, from: 413252 to: 473074
U33, from: 418020 to: 473082

CHANGE #7 –11471

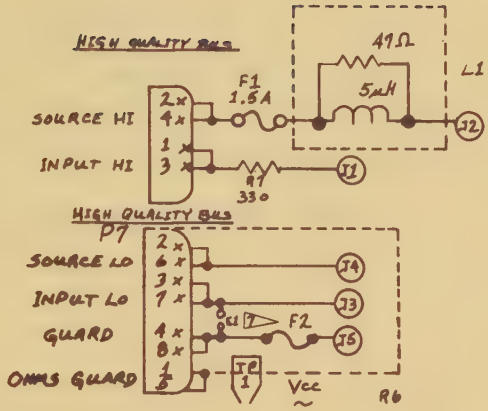
On page 8-15, make the following corrections in the upper left corner:

a.

From:



To:



b. Immediately beneath U17 and U20, add "60Ω (ALL)"

c. Beneath U29 and U30, add 1k (ALL).

CHANGE #8 – 11763

Rev. L, A2 Motherboard PCB Assembly, make the following changes:

/493981/83330/21527-102/
J42 /Binding Post, red/~~275560~~/~~32767~~/~~820-45~~/1
/493973/83330/21527-103/
J41 /Binding Post, Blk/~~275552~~/~~32767~~/~~820-65~~/1

CHANGE #9–11581

Rev-H, A7 Display PCB Assembly, make the following changes:

On page 5-24, Spacer /~~446461~~/ ~~11897~~/ ~~167-PB-0588~~/ 448432/ 89536/ 448432/ 1

CHANGE #10–11859

Rev-C, A10A2 Fast R^2 A/D Converter make the following changes:

On page 5-38, U14,U15,U17,~~U23~~, U38/IC, Linear, 5-Xstr Array/ 380188/ 02735/ CA3183E/~~5~~/4/1

Add: U23/ IC Linear, 5-Xstr Array NPN/ 477778/ 89536/ 477778/ 1

ERRATA #2

On page 4-4, Figure 4-1, make the following changes:

1. Delete connection from DC Voltage Standard Guard to Voltage Divider Input Ground.
2. Install connection between guard and Output Low (-) on DC Voltage Standard.

On page 4-5, Figure 4-2, make the following changes:

1. Install connection between guard and Output Low (-) On DC Voltage Standard.

On page 4-6, Figure 4-3, make the following changes:

1. Delete connection from DC Voltage Standard Guard to Voltage Divider Input Ground.
2. Install connection between guard and Output Low (-) on DC Voltage Standard.

Change/Errata Information

Issue No: 4 1/79

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The instrument's PCB revision letter is lower than that which is indicated at the beginning of the change/errata.

2. No revision letter is indicated at the beginning of the change/errata.

MANUAL

Title: 8500A DIGITAL MULTIMETER
Print Date: JULY 1977
Rev and Date: – – –

C/E PAGE EFFECTIVITY

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ERRATA #1

Change paragraph 4-12, step 4 to read:

4. Open hinged module top.

NOTE

Make sure the leaf spring, attached to one half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

Change paragraph 4-70, step 5 to read:

5. Using a small screwdriver or similar tool, lift and position the leaf spring, attached to one half of the module shield, so that it rests firmly over the flange of the opposite half of the module shield.

CHANGE #1–11027

On page 5-28, add the following:

Shield, relay (not shown); 469585; 89536; 469585; 1

CHANGE #2–11080

On page 5-16, change reference designator C6 to read:

C6, Cap, cer, .047 uF; 460733; 71590; CW20C473M; 1

On page 8-13, in the upper left corner:

Delete C6 (right)
Change C6 (left) to read, under description, ".047 uF".

CHANGE #3–11115

On page 5-3, delete Item No. 5 and all descriptive data.

CHANGE #4–11193

On page 5-3, change Item No. 8 data to the following:

8 Corner, 394346, 89536, 394346, 2

Change Item No. 9 data to read:

9 Handle, 394304, 89536, 394304, 2

CHANGE #5–11194

On page 5-6, change Item No. 15 to read:

15, Decal, corner. 394387, 89536, 394387, 4

CHANGE #6–11352

On page 5-16, change Fluke Stock No. and Mfg. Part No. for the following entries:

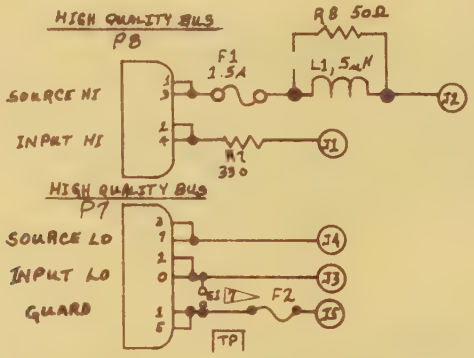
U7, from: 428813 to: 473108
U22, from: 418442 to: 473090
U25, from: 413252 to: 473074
U33, from: 418020 to: 473082

CHANGE #7–11471

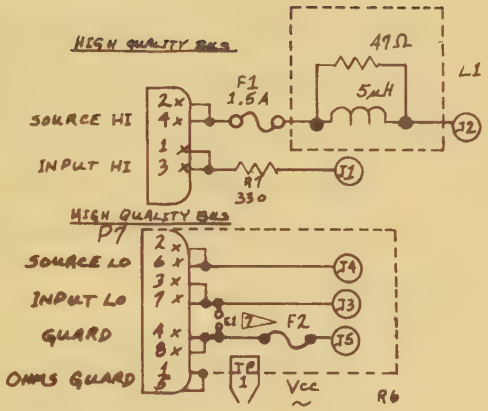
On page 8-15, make the following corrections in the upper left corner:

a.

From:



To:



b. Immediately beneath U17 and U20, add "60Ω (ALL)"

c. Beneath U29 and U30, add 1k (ALL).

CHANGE #8 – 11763

Rev-L, A2 Motherboard PCB Assembly, make the following changes:

/493981/83330/21527-102/
J42 /Binding Post, red/~~275560~~/~~32767~~/~~820-45~~/1
/493973/83330/21527-103/
J41 /Binding Post, Blk/~~275552~~/~~32767~~/~~820-65~~/1

CHANGE #9–11581

Rev-H, A7 Display PCB Assembly, make the following changes:

/448432/ 89536/ 448432/
On page 5-24, Spacer /~~446461~~/ ~~11897~~/ ~~167-PB-0588~~/ 1

CHANGE #10–11859

Rev-C, A10A2 Fast R^2 A/D Converter make the following changes:

On page 5-38, U14,U15,U17,~~U23~~, U38/IC, Linear, 5-Xstr Array/ 380188/ 02735/ CA3183E/~~5~~/4/1

Add: U23/ IC Linear, 5-Xstr Array NPN/ 477778/ 89536/ 477778/ 1

ERRATA #2

On page 4-4, Figure 4-1, make the following changes:

1. Delete connection from DC Voltage Standard Guard to Voltage Divider Input Ground.
2. Install connection between guard and Output Low (-) on DC Voltage Standard.

On page 4-5, Figure 4-2, make the following changes:

1. Install connection between guard and Output Low (-) On DC Voltage Standard.

On page 4-6, Figure 4-3, make the following changes:

1. Delete connection from DC Voltage Standard Guard to Voltage Divider Input Ground.
2. Install connection between guard and Output Low (-) on DC Voltage Standard.

CHANGE #11–12101

Rev. -F, Ohms Converter Assembly

On page 602-14, Table 602-9, make the following changes:

FROM: R63/Res, mf, 28k ±1%, 1/8W/291835/91637/MFF1082802F/1
TO: R63/Res, mf, 15.8k ±1%, 1/8W/293688/91637/CMF551582F/1

FROM: R64/Res, mf, 21k ±0.5%, 1/8W/229484/91637/MFF1-82102D/1
TO: R64/Res, mf, 73.2k ±1%, 1/8W/237222/91637/CMF557322F/1

FROM: R65/Res, mf, 17.8k ±1%, 1/8W/342183/91637/MFF1-81782F/1
TO: R65/Res, mf, 30.1k ±1%, 1/8W/168286/91637/CMF553012F/1

On page 602-16, Figure 602-5, make the following changes:

FROM: R63, 28k
TO: R63, 15.8k

FROM: R64, 21k
TO: R64, 73.2k

FROM: R65, 17.8k
TO: R65, 30.1k

CHANGE #12–12103

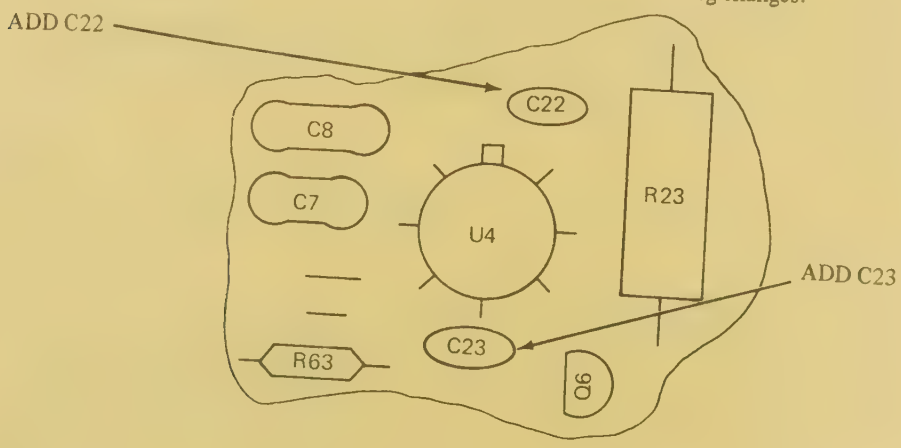
Rev. -M, A10A1 A/D Analog PCB Assembly (MIS-4140)

On page 5-32, make the following changes:

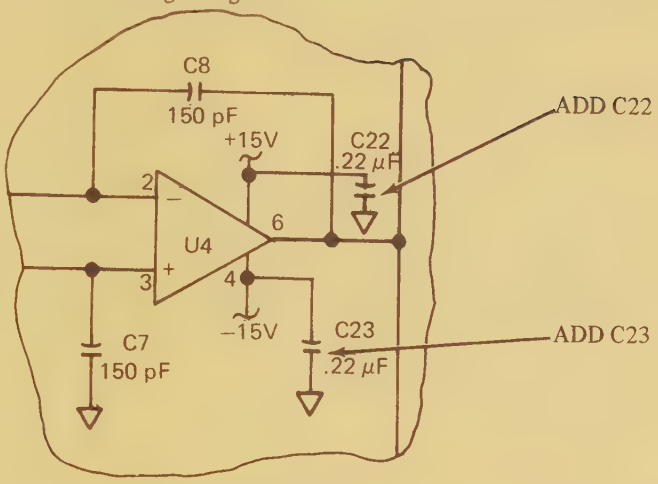
ADD: C22/Cap, cer, 0.22 μF ±20%, 50V/309849/71590/CW30C224K/Ref
C23/Cap, cer, 0.22 μF ±20%, 50V/309849/71590/CW30C224K/Ref

CHANGE: TOT QTY of C16 FROM: 2 TO: 4

On page 5-34, Figure 5-10, and page 8-21, Figure 8-17, make the following changes:



On page 8-23/8-24, Figure 8-19, make the following changes:



ERRATA #3

On page 4-7, paragraph 4-42, step 6, make the following changes:

FROM: that the voltage between RT5 and Vss reads be-
TO: that the voltage between LINE and Vss reads be-

CHANGE/ERRATA INFORMATION

ISSUE NO: 7 1/80

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The revision letter stamped on the indicated PCB* is equal to or higher than that given with each change.

2. No revision letter is indicated at the beginning of the change/errata.

* PCB rev. letters followed by a dash - number, are equivalent to the next higher rev. letter; e.g., A-1 = B.

MANUAL

Title: 8500A DIGITAL MULTIMETER
Print Date: JULY 1977
Rev. and Date: -----

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ERRATA #1

Change para. 4-12, step 4 to read:

4. Open hinged module top.

NOTE

Make sure the leaf spring, attached to one half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

Change para. 4-70, step 5 to read:

5. Using a small screwdriver or similar tool, lift and position the leaf spring, attached to one half of the module shield, so that it rests firmly over the flange of the opposite half of the module shield.

CHANGE #1 - 11027

On page 5-28, add the following:

Sheild, relay (not shown)|469585|89536|469585|1

CHANGE #2 - 11080

On page 5-16, change reference designator C6 to read:

C6|CAP, CER, 0.047 UF +/-20%, 50V|460733|71590|CW20C473M|1

On page 8-13, in the upper right hand corner:

Delete C6 (right)

Change C6 (left) to read, under description, ".047 uF".

CHANGE #3 - 11115

On page 5-3, delete Item No. 5 and all descriptive data.

CHANGE #4 - 11193

On page 5-3, change Item No. 8 data to the following:

8|Corner|394346|89536|394346|2

Change Item No. 9 data to read:

9|Handle|394304|89536|394304|2

CHANGE #5 - 11194

On page 5-6, change Item No. 5 to read:

15|Decal, corner|394387|89536|394387|4

CHANGE #6 - 11352

On page 5-16, change the Fluke Stock No. and Mfg. Part No.:

FROM: U7|428813, TO: U7|473108

FROM: U22|418442, TO: U22|473090

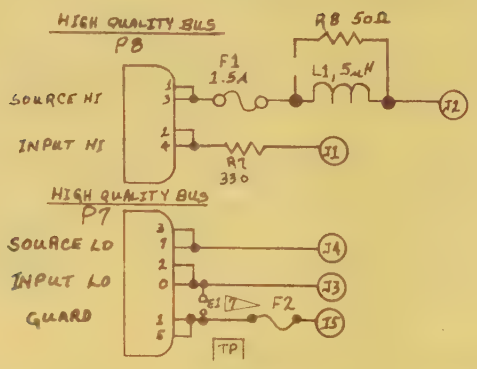
FROM: U25|413252, TO: U25|473074

FROM: U33|418020, TO: U33|473082

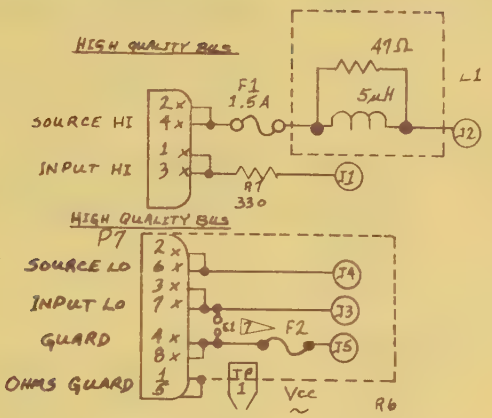
CHANGE #7 - 11471

On page 8-15, make the following corrections in the upper left hand corner:

FROM:



TO:



Also immediately beneath U17 and U20, add: "60 ohm (ALL)" and Beneath U29 and U30, add: "1 k (ALL)".

CHANGE #8 - 11763

Rev.- L, A2 Motherboard PCB Assembly

FROM: J41|BINDING POST, BLACK|275560|32767|820-45|

TO: J41|BINDING POST, BLACK|493981|83330|21527-102|

FROM: J42|BINDING POST, RED|275552|32767|820-65|

TO: J42|BINDING POST, RED|493973|83330|2157-103|

CHANGE #9 - 11581

Rev.- H, A7 Display PCB Assembly

On page 5-24:

FROM: Spacer|446461|11897|167-PB-0588|1

TO: Spacer|448432|89536|448432|1

CHANGE #10 - 11859

Rev.- C, A10A2 Fast RXR A/D Converter

On page 5-38:

Delete U23 from the U14 listing and change the TOT QTY, FROM:5, TO:4.

ADD: U23|IC Linear, 5-Xstr Array|477778|89536|477778|1

ERRATA #2

On page 4-4, Figure 4-1:

1. Delete connection from DC Voltage Standard Guard to Voltage Divider Input Ground.
2. Install connection between guard and Output Low (-) on DC Voltage Standard.

On page 4-5, Figure 4-3:

1. Install connection between guard and Output Low (-) On DC Voltage Standard.

On page 4-6, Figure 4-3:

1. Delete connection from DC Voltage Standard Guard to Voltage Divider Input Ground.
2. Install connection between guard and Output Low (-) on Dc Voltage Standard.

CHANGE #11 - 12101

Rev.- F, Ohms Converter Assembly
On page 602-14:
FROM: R63|Res,mf,28 k,±1%,1/8W|291835|91637|MFF1082802F|1
TO: R63|Res,mf,15.8 k,±1%,1/8W|293688|91637|CMF551582F|1

FROM: R64|Res,mf,21 k,±0.5%,1/8W|229484|91637|MFF1-82102D|1
TO: R64|Res,mf,73.2 k,±1%,1/8W|237222|91637|CMF557322F|1

FROM: R65|Res,mf,17.8 k,±1%,1/8W|349183|91637|MFF1-81782F|1
TO: R65|Res,mf,30.1 k,±1%,1/8W|168286|91637|CMF553012F|1
On page 602-16, Figure 602-5:
FROM: R64, 28k FROM: R64, 21k FROM: R65, 17.8k
TO: R64, 15.8k TO: R64, 73.2k TO: R65, 30.1k

CHANGE #12 - 12103
Rev.- M, A10A1 A/D Analog PCB Assembly (MIS-4140)
On page 5-32:
ADD: C22|CAP, CER, 0.22UF+/-20%, 50V|309849|71590|CW30C224K|REF
ADD: C23|CAP, CER, 0.22UF+/-20%, 50V|309849|71590|CW30C224K|REF
Change TOT QTY of C16, FROM: 2, TO: 4.
On page 5-34, Figure 5-10, and page 8-21, Figure 8-17:
Add C22 and it's symbol between C8 and R23 (just above U4).
Add C23 and it's symbol between R63 and Q6 (just below U4).
On page 8-23/8-24, Figure 8-19:
Add C22 and it's symbol between U4-6 and earth ground.
Add C23 and it's symbol between U4-4 and earth ground.

ERRATA #3
On page 4-7, para. 4-42, step 6:
FROM: ...that the voltage between RT5 and Vss reads be-...
TO: ...that the voltage between LINE and Vss reads be-...

CHANGE #13 - 10945
Rev.- K, A10A1 A/D Analog Assembly (MIS-4140)
On page 5-36:
FROM: U4,U7|IC,Op-Amp,J-FET,Input|310037|12040|LH0042CH|2|1
TO: U4,U7|IC,LIN,OP-AMP,MONOLITHIC,J-FET INPUT|429837|12040|LF356F|2|1

ERRATA #4
On page 604-1, add the following note between para. 604-8 and Step 1.

NOTE
If this option is being used in the 8502A, high resolution may be selected independently.

CHANGE #14 - 12306
Rev.-C, Power Supply Assembly (8500A-4041)
On page 5-14:
FROM: Insulator,semiconductor mtg|428821|55285|7403-10-51|5
TO: Insulator,Transistor|509630|89536|509630|5

CHANGE #15 - 11139
Rev.- H, A8 D.C. Signal Condition Assembly (MIS-4100)
Delete all reference to the sheild added in CHANGE #1.

ERRATA #5
On page 609A-2, Table 609-1:

Frequency	24 hours			90 days			1 year		
	% of Input	+% FS AC	+% FS AC+DC	% of Input	+% FS AC	+% FS AC+DC	% of Input	+% FS AC	+% FS AC+DC
ADD:									
300 kHz to 1 MHz	2.9	1.3	1.3	3.3	1.8	1.8	3.7	2.1	2.1
FROM:									
100 kHZ to 300 kHz	1.5	0.5	0.5	2.0	0.5	0.5	4.0	1.0	1.0
TO:									
100 kHZ to 300 kHz	1.5	0.5	0.5	2.0	0.5	0.5	2.8	1.0	1.0
FROM:									

NOTES: 2. Volt-Hertz product not to exceed 2 X 10 to the 7.

TO:

NOTES: 2. Volt-Hertz product not to exceed 2 X 10 to the 7 for 100V and 1000V ranges and 1 X 10 to the 7 for 1V and 10V ranges.

Under "INPUT CHARACTERISTICS" change MAXIMUM INPUT:
FROM: 1000V rms of 2 X 10 to the 7...
TO: 1000V rms or 2 X 10 to the 7...

On page 609-8, add the following heading to the top left hand column:
"609A-35a Preliminary Calibration"

On page 609A-9, make the following changes to Step 36:
FROM: Adjust R75, 1 MHz, for a reading of 10.000 ±100 digits.
TO: Adjust R75, 1 MHz, for a reading of 10.0000 ±100 digits.

On page 609A-6, Table 609A-3, make the following changes to Step 8.

FROM:	10V	10V	1 MHz	Check (R75)squared	19.8000	20.2000
TO:	10V	10V	1 MHz	Check (R75)squared	9.8000	10.2000

CHANGE #16 - 12386
Rev.- J, A8 D.C. Signal Condition Assembly (MIS-4100)
Rev.- F, Ohms Converter Assembly (MIS-4110)

On page 5-25:

FROM:	K1,K2	Relay,armature LO-profile	441261	77342	R40-E0186-1	1
TO:	K1,K2	Relay,armature LO-profile	515437	89536	515437	1

On page 602-12, Table 602-9:

FROM:	K1,K2	Relay,armature	441261	77342	R40-E0186-1	1
TO:	K1,K2	Relay,armature	515429	89536	515429	1

CHANGE #17 - 12482
On page 2-4, add the following note to Table 2-2:

NOTE

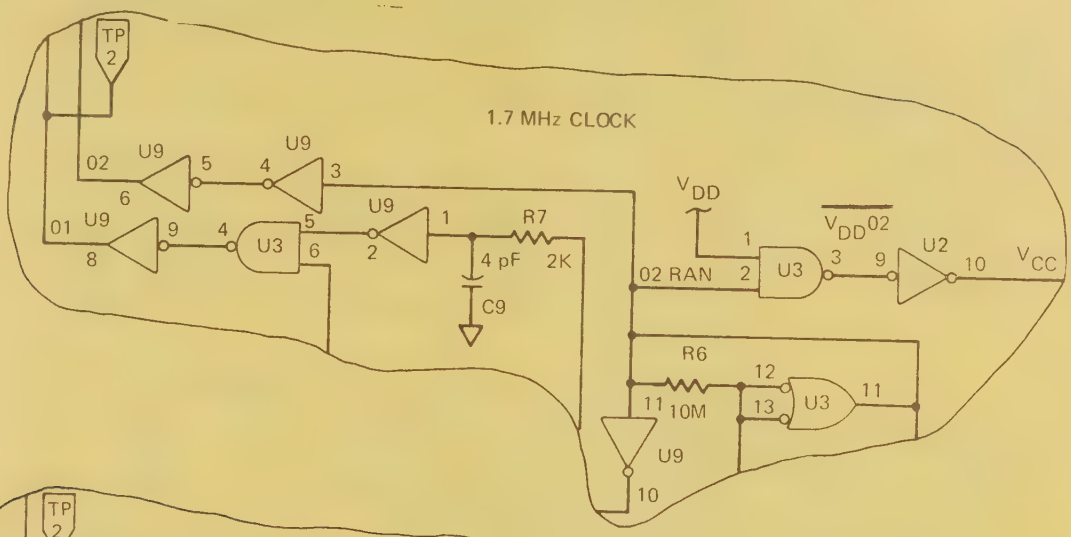
If the instrument contains an ohms (-02) option an ERROR 4 message will be displayed whenever an over voltage condition occurs. In most instances this will happen while making a four terminal short, due to the short placed between the SOURCE HI and INPUT LO terminals while the remaining terminals are still open. Normal operation of the instrument may be resumed by depressing the "OHMS" or "RESET" function buttons.

CHANGE #18 - 12500
Rev.- K, A8, D.C. Signal Conditioner Assembly (MIS-4100T)
On page 5-28:

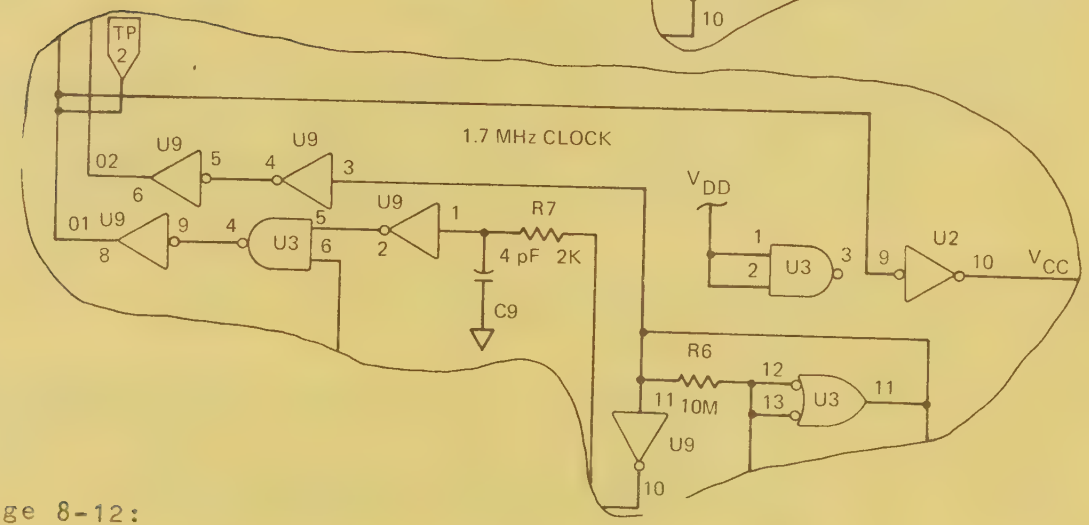
FROM:	U3,U4	IC, Op Amp, J-FET,input	310037	12040	LH0042CA	2 1
TO:	U3,U4	IC, Op Amp, J-FET	357830	12040	LH0042C	2 1

CHANGE #19 - 12623, 12642
Rev.- K, A6A1 Controller PCB Assembly (MIS-4185)
On page 8-12:

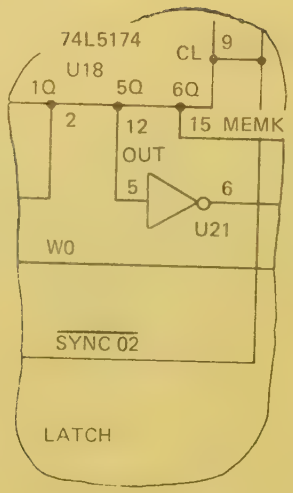
FROM:



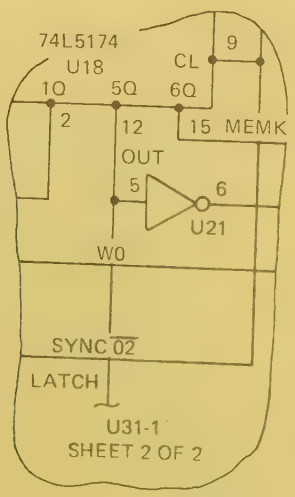
TO:



On page 8-12:
FROM:

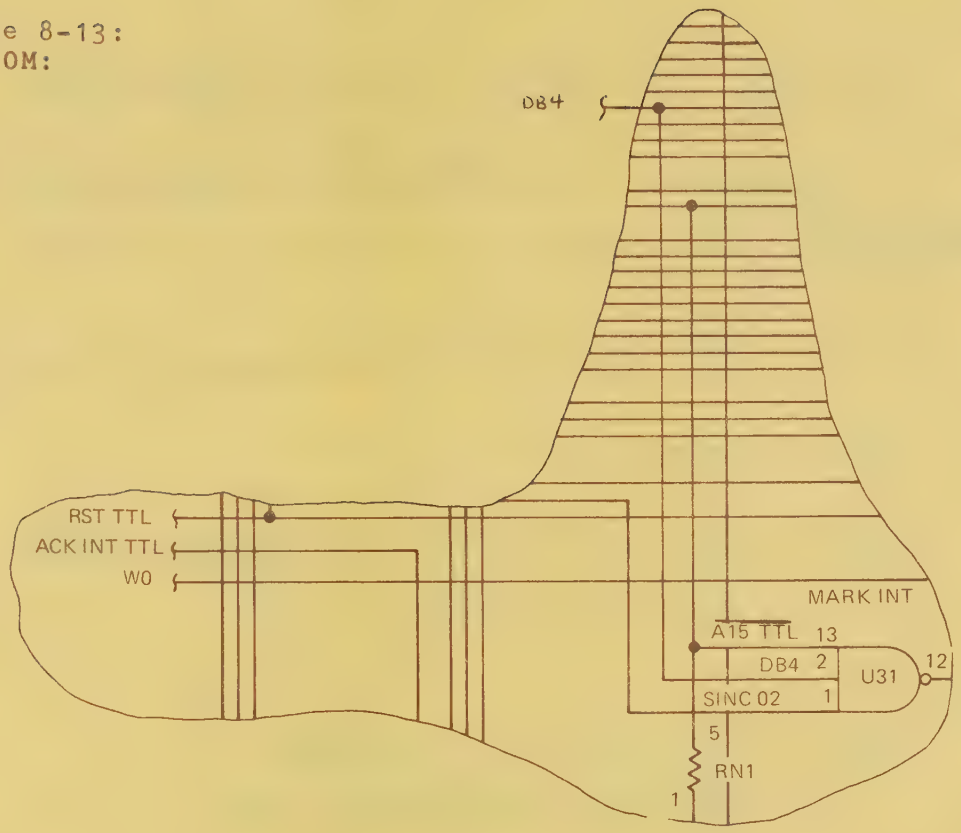


TO:

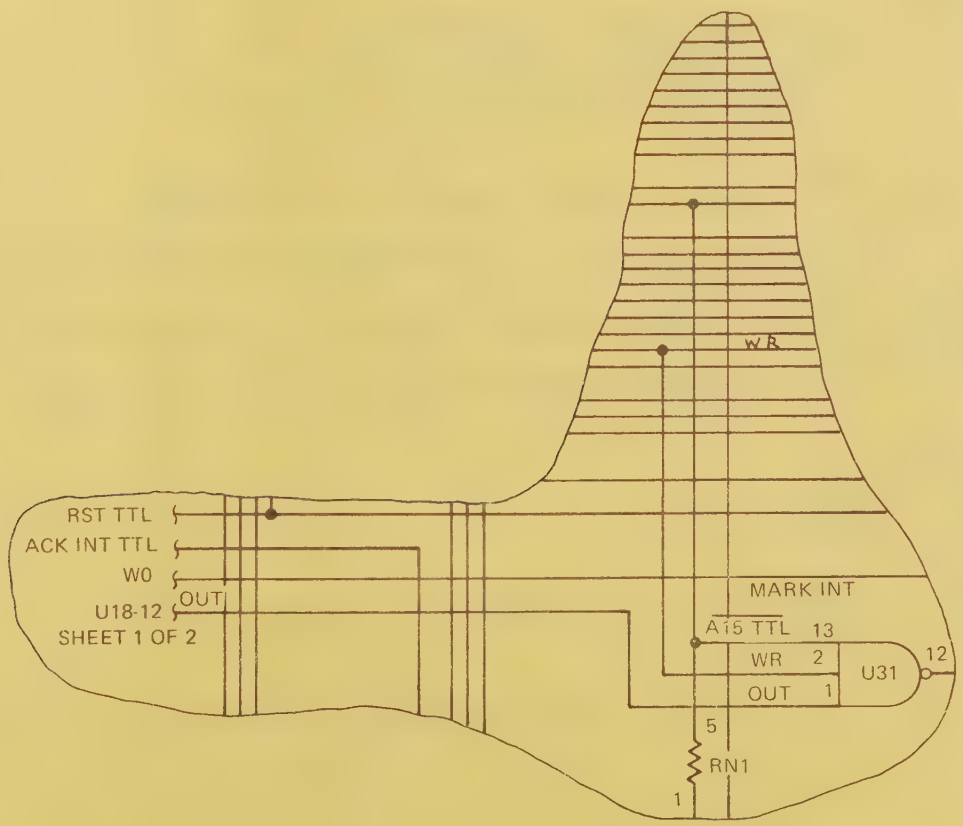


On page 8-13:

FROM:



TO:



On page 5-16:
FROM: C1|Cap,mica,15 pF,±5%,500V|148569|72136|DM15C150J|1
TO: C1|Cap,mica,22 pF,±5%,500V|148551|72136|DM15E220J|1
On page 5-17:
FROM: CR1|DIODE, SI, HI-SPEED SWITCHING|203323|07910|IN4448|1
TO: CR1,CR2|DIODE, SI, HI-SPEED SWITCHING|203323|07910|IN4448|2
On page 5-18 and 8-11:
Add CR2 and it's symbol between R1 and the side of the PCB (anode towards TP2).
On page 8-12:
Change value of C1 FROM:15 pF, TO:22 pF.
Add CR2 and it's symbol across R1 (anode connected to U9-10).

CHANGE #20 - 12873
Rev.- M, A2 Motherboard PCB Assy (8500A-4001)
On page 5-10:
ADD: 6|Washer, FLT, #8|110270|73734|1406|2
ADD: 7|Washer, Split/LK, S/Steel, #6|403923|89536|403926|2
On page 5-9:
Add items 6 and 7 between items 1 and 4.

CHANGE #21 - 12887
On page 5-3:
FROM: 10|Cover,bottom|383265|89536|383265|1
TO: 10|Cover, bottom|Order desired color|1
Blue|383265|89536|383265|Ref
Putty grey|522722|89536|522722|Ref
On page 5-6:
FROM: 12|Cover,top|383257|89536|383257|1
TO: 12|Cover,top|Order desired color|1
Blue|383257|89536|383257|Ref
Putty grey|522516|89536|522516|Ref

CHANGE #22 - 12960
Rev.- L, A8, D.C. Signal conditioner Assy (MIS-4100T)
On page 5-25:
ADD: CR5|Diode,Si,Low-Cap,Low Leakage|348177|07263|FD7223|1
On page 5-26 and 8-16:
Add CR5 and it's symbol between Q22 and U4 (anode towards Q23).
On page 8-17:
Add CR5 and it's symbol between pins 3 and 2 of U4 (anode to U4-2).

ERRATA #6
On page 602-12:
FROM: Q2,Q4...
TO: Q3,Q4...

FROM: Q3,Q12...
TO: Q2,Q12...

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Model 8500A Digital Multimeter

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. This manual is composed of eight sections containing the information necessary to install, operate, and maintain the Fluke Model 8500A Digital Voltmeter. The 8500A employs modular construction allowing numerous possible configurations. Your manual employs a modular construction designed to furnish you with the most up-to-date information possible. Sections 1 through 5 and 8 contain information relating to the 8500A mainframe, which includes the modules necessary for DC Volts and DC Ratio measurements. Section 1 contains a list of available options and a table of specifications for the mainframe. Section 2 is operating instructions, Section 3 is theory of operation, Section 4 is maintenance, Section 5 contains parts lists, and Section 8 contains schematic diagrams. Section 6 contains information relating to the options contained in your instrument, including the specifications, operating instructions, theory of operation, maintenance, parts lists, and schematics. As the need arises to expand your 8500A system, the most up-to-date information for the options you order will be included with them. Section 7 is general information: lists of abbreviations, federal supply codes, Service Centers, and Sales Representatives.

1-3. DESCRIPTION

1-4. Mainframe

1-5. The Model 8500A Digital Voltmeter is a six and one-half digit instrument employing microprocessor control and a bus structure. All active components are contained in modules which plug into a mainframe motherboard. The modules function under direct control of a microprocessor-based controller, which addresses each module as a memory location, similar to a computer. Modular construction allows considerable versatility in option selection and reduction of downtime by simple replacement of a faulty module.

1-6. The use of microprocessor control gives rise to "virtual" modules through arithmetic processing. External referencing and offsets, normally requiring separate circuitry, are performed by taking separate measurements, storing the values in memory, and operating on them arithmetically. Digital filtering is accomplished by taking a number of samples synchronous to the line frequency at a rate equal to an even multiple of the line frequency and averaging them for each reading. Limits and high/low peak detection are available through an optional remote interface.

1-7. Fluke's patented recirculating remainder (R^2) technique of A/D conversion has been adapted to microprocessor control. This method provides fast, accurate, linear measurements with long-term stability.

1-8. Options

1-9. A list of options available for the 8500A is contained in Table 1-1. Two ac converter options, an ohms converter option, and a current shunts option complete the analog capability of the 8500A. Three possible remote interfaces may be used for systems operation, but only one may be installed at a time. If a remote interface is installed, the isolator option must replace the interconnect pcb to maintain guarding of the analog and high-quality busses. The three remote interface options allow maximum versatility in interfacing the 8500A to digital systems. A calibration memory option reduces downtime due to calibration requirements. Correction factors for each range, derived from a standard input, may be entered from the front panel. Further measurements are then automatically corrected with the calibration factor. Table 1-2 is a list of accessories available for the 8500A.

1-10. SPECIFICATIONS

1-11. Specifications relating to the 8500A mainframe (DC Volts and DC Ratio measurements) are presented in Table 1-3. Specifications for the instrument with options are presented with the information relating to each option in Section 6. The table of specifications has been divided into two parts: Accuracy, and Instrument Operating Characteristics. Accuracy specifications have been consolidated for ease in reference both by the user in divergent

applications and by the metrologist in performance determination. Detailed instrument operating characteristics have been provided to assure exact knowledge of the Model 8500A performance in every unique situation.

Table 1-1. 8500A Options

Option No.	Name	Notes
01	AC/DC Converter (Averaging)	1,3
02	Ohms Converter	
03	Current Shunts	3
04	Calibration Memory	
05	IEEE Standard 488-1975 Interface	2
06	Bit Serial Asynchronous Interface	2
07	Parallel Interface	2
08	Isolator	4
09	AC/DC Converter (True RMS)	1,3
17	Rear Input	

1) Options 01 and 09 cannot be installed simultaneously.
2) Only one of Options 05, 06, and 07 can be installed at any time.
3) For the AC portion of Option 03 to operate, either Option 01 or 09 must be installed.
4) Option 08 must be installed for remote operations.

Table 1-2. 8500A Accessories

Model or Part No.	Name
M04-205-600	Rack Ear Mounting Assembly
M00-260-610	18-inch Rack Slides
M00-280-610	24-inch Rack Slides
80F-5	High Voltage Probe
80F-15	High Voltage Probe
81RF	High Frequency Probe
82RF	High Frequency Probe
KDM1	Keyboard Display Module w/Cable
Y8001	IEEE Std. Cable, 1 Meter Length
Y8002	IEEE Std. Cable, 2 Meter Length
Y8003	IEEE Std. Cable, 4 Meter Length
MIS-7011K*	Extender Assembly
MIS-7190K*	Static Controller
MIS-7191K*	Test Module
MIS-7013K*	Bus Interconnect and Monitor

*For use during service or repair

Table 1-3. Specifications

ACCURACY

Note

The stated accuracies are valid under the following environmental conditions.

Temperature: 18°C to 28°C (Except 24 hour: 22°C to 24°C)

Humidity: ≤75%

Line Regulation: 90V to 110V, 103.5V to 126.5V, or 207V to 253V @ 45 to 66 Hz

DC Volts

Normal Resolution (Not in CAL Mode)					
Range	Full Scale	Resolution	Accuracy + (% of Input + Number of Digits)		
			24 Hours	90 Days	1 Year
100 mV	312 mV	1 uV	0.002 + 4	0.003 + 5	0.005 + 8
1 V	2.5 V	10 uV	0.001 + 1	0.002 + 1	0.004 + 1
10 V	20 V	100 uV	0.001 or 1*	0.001 + 1	0.002 + 1
100 V	160 V	1 mV	0.001 + 1	0.002 + 1	0.004 + 1
1000 V	1200 V	10 mV	0.001 + 1	0.002 + 1	0.004 + 1

Whichever is greater.

Table 1-3. Specifications (Continued)

ACCURACY (Continued)

DC Volts (Continued)

High Resolution (In CAL Mode)

Range	Full Scale	Resolution	Accuracy ± (% of Input + Number of Digits)		
			24 Hours	90 Days	1 Year
1 V	2.5 V	1 uV	0.001 + 6	0.002 + 8	0.004 + 9
10 V	20 V	10 uV	0.001 or 6*	0.001 + 8	0.002 + 9
100 V	160 V	100 uV	0.001 + 6	0.002 + 8	0.004 + 9
1000 V	1200 V	1 mV	0.001 + 6	0.002 + 8	0.004 + 9

*Whichever is less.

DC Ratio

Ext. Ref. Voltage	Accuracy
±20V to ±40V	±(A + B + 10 ppm)
$\pm V_{min.}$* to ±20V	$\pm\left(A + B + \frac{200\ ppm}{\lvert V_{xref} \rvert}\right)$

A =10V dc Range Accuracy
B =Input Signal Function and Range Accuracy
V_{min} =Minimum Allowable External Reference Voltage
$|V_{xref}|$ =Absolute Value of External Reference Voltage

*The formula for determining V_{min} is included in Instrument Operating Characteristics

Example Calculations for External Reference Accuracy:

1. Input = + 90.000V, Ext. Ref. Input = 30.000V (+ 15V to Ext. Ref. HI, −15V to Ext. Ref. LO)
   A = .001% + 1 Digit B = .001% + 1 Digit
   Ratio Accuracy = ±(A + B + 10 ppm) = ±(.001% + 1 Digit + .001% +1 Digit + .001% = ±(.003% +2 Digits)
   Reading may be between 3.0003 and 2.9997

2. Input = 1.20000V, Ext. Ref. Input = .12000 (V_{min} for 1V Range)
   A = .001% + 1 Digit, B = .001% + 1 Digit, $\frac{200\ ppm}{V_{xref}} = \frac{.02\%}{.12} = .1667\%$

   Ratio Accuracy = ±.001% + 1 Digit + .001% +1 Digit + .1667%) = ±(.1687% + 2 Digits)
   Reading may be between .998313 and 1.001686.

INSTRUMENT OPERATING CHARACTERISTICS

DC Volts

TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)

Range	Temperature Coefficient
100 mV	± (3 ppm/reading + 0.5 digit)/°C
1V	±(3 ppm/reading +0.1 digit)/ °C
10 V	± (2 ppm/reading + 0.05 digit)/°C*
100 V	± (3 ppm/reading + 0.1 digit)/°C*
1000 V	± (3 ppm/reading + 0.05 digit)/°C*

*For High Resolution Multiply Digits by 10.

INPUT IMPEDANCE

Range	Input Impedance
100 mV	>10,000 MΩ
1V	>10,000 MΩ
10 V	>10,000 MΩ
100 V	10 MΩ
1000 V	10 MΩ
Guard to Chassis	5.6 MΩ

INPUT BIAS CURRENT

	At time of Cal	30 Days (23°C ± 1°C)	Temperature Coefficient
Bias Current	<±5 pA	<±50 pA	±3 pA/°C

Table 1-3. Specifications (Continued)

INSTRUMENT OPERATING CHARACTERISTICS (Continued)

DC Volts (Continued)

RESPONSE TIME

Digitizing Time			Analog Settling Time Within Voltmeter		
Mode of Operation	Reading Rate	Digitizing Time	Filter Mode	Step Input to 0.01% of Change	Step Input to 0.001% of Change
Bench	50 Hz line 6-1/4 rdg/sec	162 ms	Bypassed Filter <100k Source Resistance (Remote)	2 ms	20 ms
	1-1/2 rdg/sec	642 ms			
	60 Hz line 7-1/2 rdg/sec	136 ms			
	1-7/8 rdg/sec	546 ms			
Remote	50 Hz 4 samples/rdg*	22 ms	Filter, Fast	40 ms	50 ms
	60 Hz 4 samples/rdg*	18 ms	Filter, Slow (Manual)	400 ms	500 ms

**Number of samples per reading is remotely programmable from 1 (2^0) to 131,072 (2^{17}) in 18 binary steps.*

ZERO STABILITY

Better than 5 μV for 90 days after a one hr. warm-up. Front Panel pushbutton auto zero is provided. The zero correction is stored in memory until power is interrupted or the 8500A is RESET. If calibration memory Option –04 is installed, the zero correction is retained.

OVERLOAD

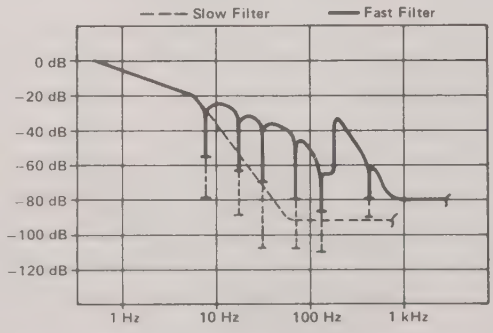
± 1200V DC to 60 Hz, or 1400V peak AC above 60 Hz may be applied continuously to any dc range without permanent damage. Maximum common mode rate of voltage rise is 1000V/μsec.

NOISE REJECTION

Normal Mode						Common Mode	
Line/Filter Frequency	4 Samples/ Rdg*	7-1/2 rdg/s	6-1/4 rdg/s	1-7/8 rdg/s	1-1/2 rdg/s	True	Effective
50 Hz Fast Filter	60 dB	N/A	70 dB	N/A	75 dB	100 dB at 60 Hz for 1 KΩ unbalance	Sum of Common Mode Rejection and Normal Mode Rejection
50 Hz Slow Filter	85 dB	N/A	90 dB	N/A	95 dB		
60 Hz Fast Filter	60 dB	70 dB	N/A	75 dB	N/A		
60 Hz Slow Filter	90 dB	95 dB	N/A	100 dB	N/A		

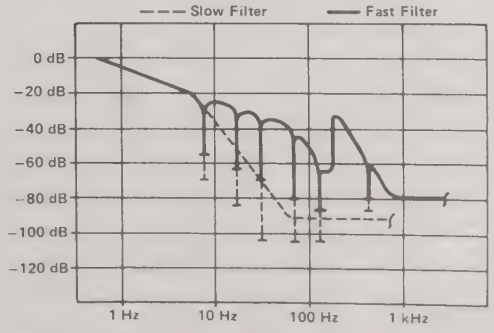
**Remotely selected*

1-7/8 Readings/Second
Typical Performance with 60 Hz Line



Cusps shown are at multiples of 60 Hz line frequency

1-1/2 Readings/Second
Typical Performance with 50 Hz Line



Cusps shown are at multiples of 50 Hz line frequency

Table 1-3. Specifications (Concluded)

INSTRUMENT OPERATING CHARACTERISTICS (Continued)

DC Ratio

INPUT IMPEDANCE

Ext Ref HI or LO X 10,000 MΩ relative to Ohms Guard* or Sense LO

BIAS CURRENT

Ext Ref HI or LO relative to Ohms Guard* or Sense LO <5 nA

SOURCE IMPEDANCE

Resistive Unbalance (Ext Ref HI to LO) <4 kΩ

Total Resistance Sense LO from either HI or LO <20 kΩ

OVERLOAD (Ext Ref HI or LO)

±180 volts peak, 127V rms (relative to Ohms Guard* or Sense LO) X (360V peak HI to LO)

**Ohms Guard available through rear input option*

NOISE REJECTION

Normal Mode	Common Mode, All Inputs Driven
Sense Input—Same as dc volts	**Sense Input**—Same as dc volts
Ext Ref Input—dc, line frequency and 2x line frequency >100 dB	**Ext Ref Input**—Line frequency and 2x line frequency, 75 dB

RESPONSE TIME

Settling Time

Sense Input Fast Filter < 50 ms to 0.001% of change
Sense Input Slow Filter < 500 ms to 0.001% of change

Digitizing Time

NOTE

The Sense Input is measured prior to measuring Ext Ref HI and LO.

Ext Ref Input—Each input HI and LO

90 ms at 60 Hz line frequency
107 ms at 50 Hz line frequency

Ext Ref Calibration—12 ms

Sense Input

Mode of Operation	Line Volt	Approx. Rdg. Rate	Digitizing Time
Bench	60 Hz	4½ rdg/s	136 ms
		1½ rdg/s	536 ms
	50 Hz	3½ rdg/s	162 ms
		1¼ rdg/s	642 ms
Remote	60 Hz	4 samples/rdg	18 ms
	50 Hz	4 samples/rdg	22 ms

EXT REF VOLTAGE RANGE

Maximum Ext Ref Voltage = ±40V between Ext Ref HI and LO terminals, providing neither terminal is greater than ±20V relative to the Sense LO or Ohms Guard terminals.

Minimum Ext Ref Voltage = ±0.0001V, or $\frac{V_{input}}{\text{Maximum Display within Range (See Table Below)}}$ (whichever is greater)

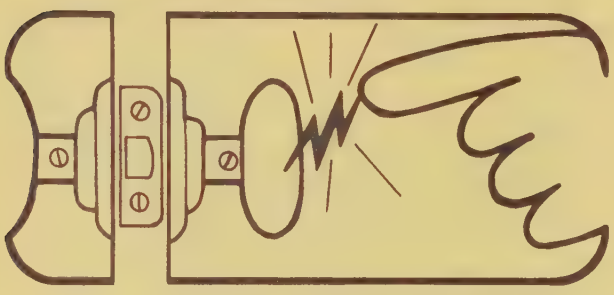
MAXIMUM DISPLAY—(Ratio/Scaling)

AC & DC VOLTS		AC & DC CURRENT		OHMS	
Range	Maximum Display (V/V)	Range	Maximum Display (A/V)	Range	Maximum Display (Ω/V)
100 mV	$\pm 999.999 \times 10^{-3}$	100 uA	$\pm 999.999 \times 10^{-6}$	10 Ω	±99.9999
1 V	±9.9999	1 mA	$\pm 9.99999 \times 10^{-3}$	100 Ω	±999.999
10 V	±99.9999	10 mA	$\pm 99.9999 \times 10^{-3}$	1 kΩ	$\pm 9.99999 \times 10^{3}$
100 V	±999.999	100 mA	$\pm 999.999 \times 10^{-3}$	10 kΩ	$\pm 99.9999 \times 10^{3}$
1000 V	±1279.99	1 A	±1.2799	100 kΩ	$\pm 999.999 \times 10^{3}$
				1 MΩ	$\pm 9.99999 \times 10^{6}$
				10 MΩ	$\pm 99.9999 \times 10^{6}$
				100 MΩ	$\pm 999.999 \times 10^{6}$

static awareness

A Message From

John Fluke Mfg. Co., Inc.

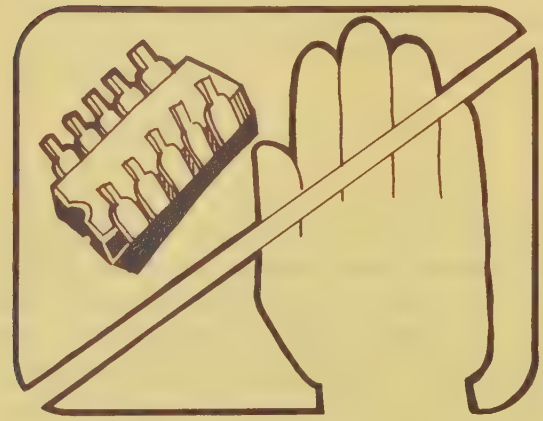


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

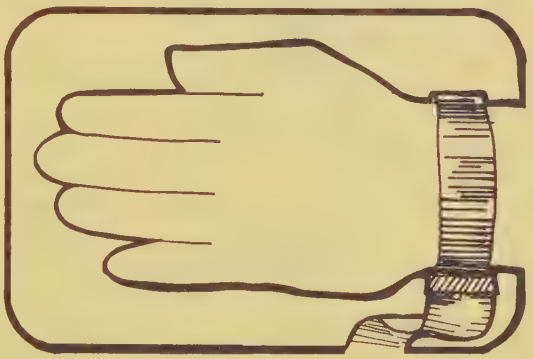
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗".

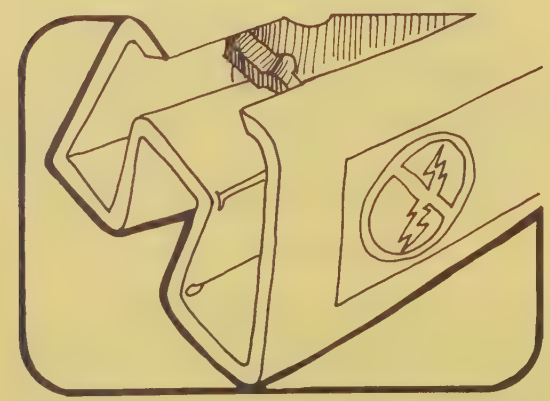
The following practices should be followed to minimize damage to S.S. devices.



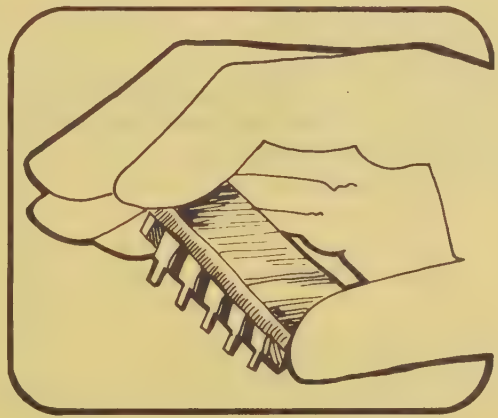
1. MINIMIZE HANDLING



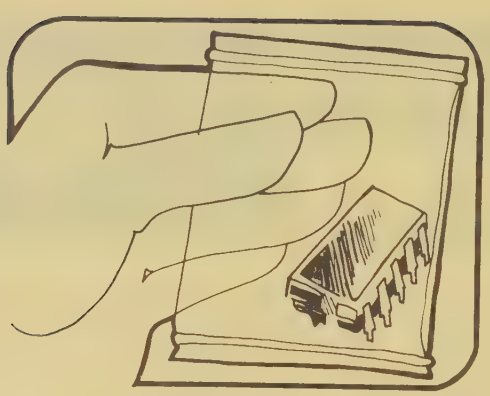
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



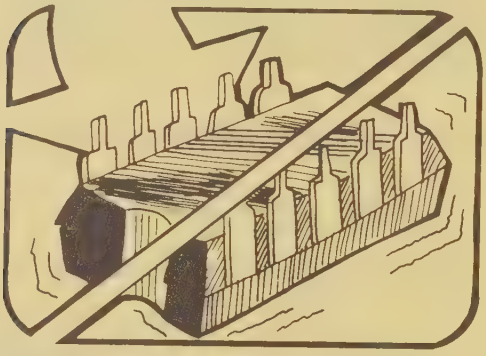
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



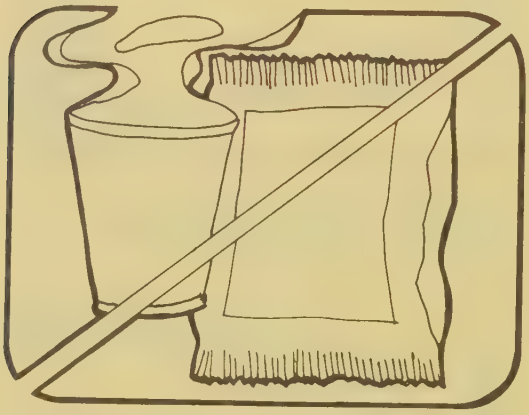
4. HANDLE S.S. DEVICES BY THE BODY



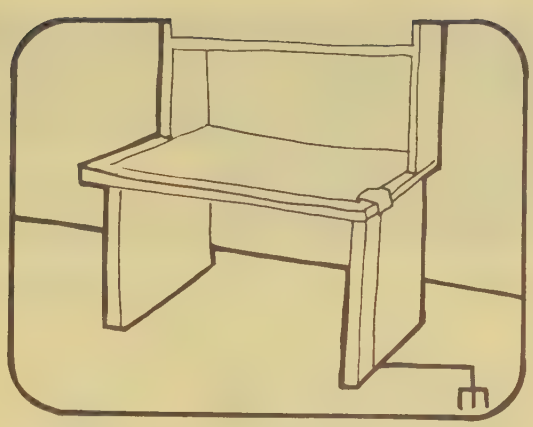
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYRAFOAM IN WORK AREA



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

9. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

10. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Bag Size
453522	6" x 8"
453530	8" x 12"
453548	16" x 24"
454025	12" x 15"

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the Model 8500A Digital Voltmeter. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, contact your nearest John Fluke Sales Representative or the John Fluke Mfg. Co., Inc.; P. O. Box 43210; Mountlake Terrace, WA 98043; telephone (206) 774-2211. A list of Sales Representatives is located in Section 7 of this manual.

2-3. SHIPPING INFORMATION

2-4. The 8500A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included with the shipping container.

2-5. If reshipment is necessary, the original container should be used. If the original container is not available, a new container can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INSTALLATION

2-7. Non-marring feet and a tilt-down bail are installed on the instrument for field or bench use. A rack-mounting kit and rack slides are available for use with standard 19-inch equipment racks. Information regarding installation of rack-mounting accessories is contained in Section 6.

2-8. Input Power Requirements

2-9. The 8500A operates from either 115V ac ± 10% or 230V ac ± 10%, 50 or 60 Hz (103.5 to 126.5V ac, or 207 to 253V ac, 45 to 66 Hz). The line voltage that the 8500A is operated from must be within the specified tolerance. A binding post on the rear panel has been provided to assure a proper earth ground connection. Section 4 contains instructions for switching the power supply from accepting 115V ac to 230V ac or vice versa. Operation at 50 Hz is the same as at 60 Hz except for slower response times.

CAUTION

Unless the chassis of the 8500A is properly grounded, the possibility of electrical shock may occur when measuring high ac voltage with the leads reversed (Input HI grounded). The ground connection has been provided in the three-prong connector.

2-10. Fuses

2-11. The line fuse is located on the rear panel near the heatsink. Use a ½ A MDL (slow-blow) fuse for replacement. The current protection fuse is located in the lower right-hand corner of the front panel. Use an AGC 1½ A replacement fuse.

2-12. OPERATING FEATURES

2-13. The location and function of all 8500A controls, indicators, and connectors are shown in Figure 2-1 and described in Table 2-1.

2-14. OPERATING NOTES

2-15. General

2-16. Upon applying power to the 8500A, the display will read "HI" and then the option configuration (Cxxxxx, where x is the installed option number). During this period a function and range may be selected; if not, the instrument will place itself in the DC Volts function, 1000V range. All front panel switches except the power switch and the CAL switch are momentary contact switches. If a switch is held in continuously, it will be "read" only one time (automatic debouncing). For rated measurement accuracy, the 8500A should be allowed to warm up for one hour.

2-17. The display consists of five and one-half digits with an exponent to give readings in engineering notation. Decimal placement and reading and exponent polarity are automatically provided. If desired the exponent may be replaced by an extra digit of resolution (refer to the explanation for the CAL mode switch later in this section).

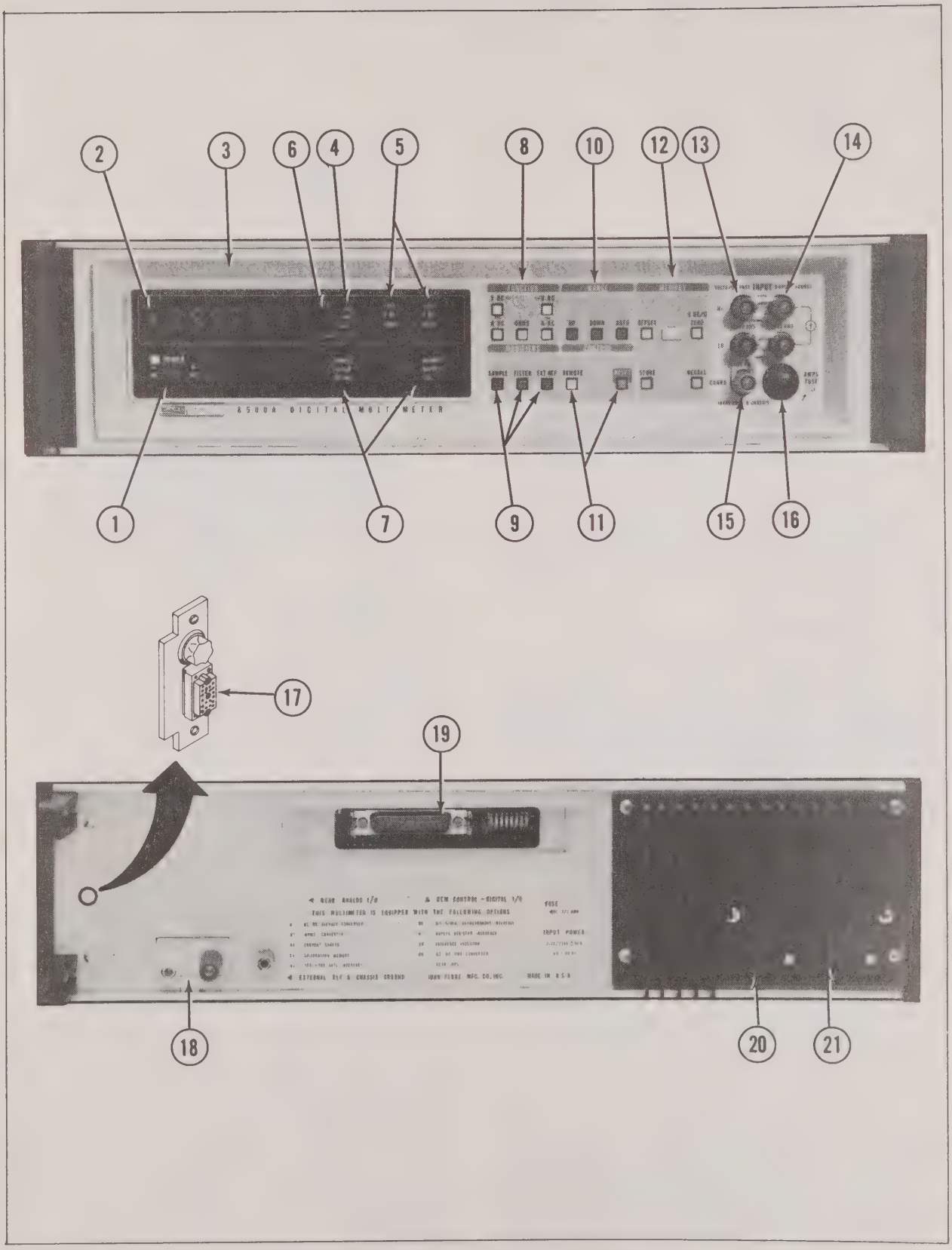


Figure 2-1. 8500A Controls, Indicators, and Connectors

Table 2-1. 8500A Controls, Indicators, and Connectors

REF. NO.	NAME	FUNCTION
1.	Power Switch	Push on/Push off for line power
2.	Polarity Display	Displays polarity of readings when appropriate
3.	Digit Display	Displays value of reading with properly positioned decimal
4.	Exponent Display	Displays exponent for engineering notation
5.	Range and Function Indicators	LEDs illuminate to indicate function selected and whether or not in autorange
6.	Modifier Indicators	LEDs illuminate to indicate modifiers selected, sample indicator blinks at reading rate selected
7.	Control and Memory Indicators	LEDs illuminate to indicate status of remote, offset, and CAL modifiers
8.	Function Switches	Selects function—DC Volts, AC Volts, DC and AC Volts, DC Current, AC Current, and Ohms. Optional modules must be installed for other than DC volts. Error 9 will be displayed if a function is selected for which the module is not installed
9.	Modifier Switches	Selects samples/rdg rate, filter (fast or slow) and external reference
10.	Range Switches	UP and DOWN change the range one range at a time, AUTO selects or disables autoranging
11.	Control Switches	REMOTE toggles control from front panel to remote-selecting remote disables all front panel switches except POWER and REMOTE. RESET initiates a master program restart (to the beginning)
12.	Memory Switches	OFFSET, VDC/Ω ZERO, STORE, and CAL are used to place values into memory for computations. ZERO and CAL factors are applied automatically. OFFSET function must be selected separately from entering a value into memory. CAL may be used to obtain an extra digit of resolution in all but the lowest range. RECALL is used to display a previously entered CAL, OFFSET, or DC ZERO factor.
13.	Input VOLTS/Ω Sense Terminals	HI and LO connections for DC and AC voltages and Ohms measurements
14.	Input AMPS/Ω Source Terminals	HI and LO connections for Current and Ohms measurements
15.	Guard Terminal	For guarded measurements (should always be connected)
16.	Current Fuse	Use a 1½ Amp Fast Blow Fuse
17.	Parallel Rear Analog Input Terminals	Optional terminals having same functions as those on front panel with the addition of an Ohms guard terminal
18.	Ext Ref Terminals	Input for external referencing
19.	Interface Connector and Switches	Connector and address switches installed on a remote interface module accessible through the rear panel
20.	Line Fuse	Use an MDL ½ (slo-blow)
21.	AC Line Voltage Connector	Three-prong connector accepting line cord with ground wire

CHECK ERRATA

CHANGE #17

2-18. Function Selection

2-19. A function may be selected simply by depressing the switch for the desired function. DC volts is standard with the 8500A mainframe. For ac volts, dc or ac current, and ohms functions, optional modules must be installed in the 8500A. Operations peculiar to each function will be explained in Section 6. If a function is selected for which the option is not installed, Error 9 will be displayed.

2-20. Error Codes

2-21. The Front Panel display and the optional interface output will indicate an error by displaying an Error Code. For operator convenience, a pull out tab, under the instrument on the right side, contains a set of condensed operating instructions which lists the errors associated with the various codes. The codes and the errors causing them are listed in Table 2-2. If the CAL mode is selected, Error Codes will not be displayed. Any function may be selected, and if the module is not installed, random readings will be displayed.

2-22. DC Voltage Measurement

2-23. The Model 8500A mainframe measures dc volts in five ranges (100 mV to 1000V). Resolutions from 1μV on the lowest range to 1 mV on the highest range are available. Overrange or full-scale capabilities progress in an octal relationship from 312 mV on the lowest range to 1200V on the highest range. All ranges are completely protected from overload conditions as specified in Section 1. Input impedance is greater than 10,000 megohms in the 100 mV, 1V, 10V ranges; 10 megohms in the 100V and 1000V ranges. DC voltage accuracies are specified in Section 1.

2-24. Input Terminals

2-25. For dc voltage measurements, the Input HI terminals may be left strapped together and the Input LO terminals may be strapped together. For most measurements it is sufficient to strap the guard terminal to the Input LO terminal. Shorting links have been provided for making these connections. A more complete description of the use of the guard terminal is included later in this section. Do not ground the Input HI terminal and drive the LO terminal as the guard bleeder resistor will reduce the input impedance to 5.6 MΩ.

CAUTION

The guard terminal should not be left disconnected as common mode voltages may exceed the LO to guard voltage rating, possibly resulting in damage to the instrument.

2-26. Range Selection

2-27. Autoranging may be selected by depressing the AUTO switch. When autoranging is selected, the AUTO LED in the display will light. Depressing the AUTO switch again will select manual ranging without changing the range. Depressing the UP or DOWN switches will also select manual ranging while changing the range one at a time in the desired direction. When the voltage at the input terminals exceeds the full-scale value for a range, the digit display will flash HHHHHH on and off at the sample rate unless the cal mode has been selected. When a valid function switch is depressed, the instrument automatically shifts to autoranging.

Table 2-2. Error Codes

CODE	FAULT
Error	System error — if the error message appears prior to the introductory messages at power initialization or reset, the problem is with the calibration memory module.
Error 0	VDC/Ω Zero Error — either a VDC/Ω Zero was attempted in a range other than 100mV or 10Ω, or an overrange value was entered.
Error 1	Offset error — either down ranging was attempted past the range of the offset, the offset was recalled in a different function than was stored, or it was toggled into offset in a function where an offset value was not stored.
Error 2	Filter Module error — the Module is faulty or not installed.
Error 3	DC Signal Conditioner error — the Module is faulty or not installed.
Error 4	Ohms or Current error — excessive voltage applied to the selected module, shorting links not properly connected, or the selected module is faulty.
Error 5	R^2 A/D error — the recircuitating remainder analog to digital converter module is faulty or not installed.
Error 6	Numeric display overflow error.
Error 7	External reference error — the magnitude of one of the ext ref inputs is greater than 20V dc.
Error 8	Controller error — the module is faulty or not installed.
Error 9	Function Selection error — the function module selected, other than dc volts, is faulty or not installed.

2-28. Modifier Selection

2-29. SAMPLE RATE

2-30. Two sample rates are available from the front panel: 128 samples/reading and 32 samples/reading. The resulting reading rates are approximately 2 readings/second and 8 readings/second respectively for a 60 Hz line frequency (6 rdgs./sec. and 1½ rdgs./sec. for 50 Hz operation). Samples are taken syncronous to the line frequency so the greatest line noise rejection is at the 2 readings/second rate. (The larger the number of samples averaged the greater the line noise rejection.) The SAMPLE indicator LED flashes at the rate the readings are being taken.

2-31. FILTERING

2-32. The front panel FILTER switch selects either a fast filter or a slow filter. Fast and slow refer to the settling times required for each filter. When the FILTER LED is illuminated, the slow filter has been selected. The slow filter has a faster roll-off below 60 Hz and provides better normal mode noise rejection at 60 Hz than the fast filter. The fast filter discriminates against higher frequency and harmonically-related line noise and should be used when faster settling times for stepped input functions are required and where noise is not a problem.

2-33. EXTERNAL REFERENCE

2-34. The external reference feature may be used to divide an input to the input terminals (any function) by the value of dc voltage applied to the External Reference input terminals located on the rear panel.

$$\text{Reading} = \frac{\text{Input}}{\text{dc Ext. Ref. Input}}$$

This is a true ratio measurement arrived at by measuring the values at the two sets of input terminals. Then the reading is computed by the microprocessor in the Controller Module. The External Reference terminals will only accept a dc voltage. The maximum value which may be applied is ± 20V to either terminal with respect to the SENSE LO terminal or ohms guard [on the optional rear panel input terminals (Option –17)] A connection must be made from Sense LO to either External Reference HI or LO having a total resistance of less than 20 kΩ. So a maximum of 40V may be applied between the external reference terminals. The minimum voltage which may be applied is $\pm 100\ \mu V$ or the absolute value of the input to the Volt/Ω terminals divided by the maximum display within the input range when in the external reference mode, whichever is greater. A table of the maximum displays for each range when in the external reference mode is included in the specifications in Section 1.

$$V_{min} = \frac{|\text{Vinput}|}{\text{Maximum Display Within Range}}$$

Example: Voltage applied to the Volt/Ωterminals = –8.0000 V

Maximum Display Within 10V range (ext ref mode) = ±99.9999

$$V_{min} = \frac{8.0000\text{V}}{99.9999} = .0800001\text{ V}$$

2-35. External reference is selected by depressing the EXT REF switch. If the switch is held in, the display will read out the value of dc voltage applied to the External Reference terminals (this value is displayed only when selecting the external reference mode). The external reference mode is turned off by depressing the EXT REF switch again.

2-36. Two examples of accuracy determination have been included in the specifications in Section 1. These examples are of most use to a metrologist in that known inputs were used and allowable deviations were the results. The following is an example of determining a pure percentage (without ± digits) to be applied to unknown inputs.

Measured Volt/Ω input = 9.0000V

Measured Ext. Ref. input = 2.0000V

$$\text{Accuracy} = \pm\left(A + B + \frac{200\text{ ppm}}{|\text{Vxref}|}\right)$$

where A = 10V dc range accuracy
B = Input signal function and range accuracy
|Vxref| = Absolute value of external reference input

A = .001% + 1 digit $\quad \frac{200\text{ ppm}}{\text{Vxref}} = \frac{.02\%}{2}$

B = .001% + 1 digit

A & B = .002% + 2 digits

$\frac{200\text{ ppm}}{|\text{Vxref}|}$ = .01%

Accuracy = .012% + 2 digits

Translating digits to percentage:

Ratio Reading = 4.5000

Same number of digits behind decimal as in maximum range reading

2 digits is .0044% of 4.5000 $\left(\frac{.000044}{4.5\sqrt{.0002}}\right)$

Accuracy expressed as a percentage = ± .0164%

2.37. Safety Warning Indications

2-38. In the external reference and offset modes when an input at the terminals exceeds 40 volts, the exponent figure flashes the symbol "H" to warn the operator that a more dangerous voltage is present at the input than is displayed by the 8500A. If the CAL switch is in the Cal mode position (CAL indicator illuminated) no indication of warning is given. An example would be when the external reference input is equal to 10 volts and the input at the terminals is 50 volts. This gives a reading of 5 volts which does not show the operator that a potentially dangerous voltage is present on the input terminals. The flashing indicators are a warning only. They have no effect on the operation of the instrument.

2-39. Control

2-40. Depressing the REMOTE switch places the instrument in remote control. When in remote, only the REMOTE switch and the POWER switch will have any effect on the operation of the instrument. Depressing the REMOTE switch a second time or briefly removing the power will return the instrument to front panel control. When placed in remote, the operation of the instrument will cease (except the display) until new commands are received through an optional remote interface.

2-41. The RESET switch is used to start the main program over again. The display will read out "HI" and then the option configuration. If a function or range is not selected during this period, the instrument will place itself in the DC Volts function, 1000V range.

2-42. Memory

2-43. OFFSET

2-44. The OFFSET switch is used to select or disable the offset mode. In the offset mode, whatever offset value has been entered into memory will be automatically subtracted from subsequent readings. To enter an offset value into memory, first apply that input value (any function) to the Volt/Ω input terminals. Depress the STORE switch. A "?" will be displayed. Then depress the OFFSET switch. The value applied to the input terminals is now entered in memory. The instrument may already be in the offset mode when entering a value into memory. If not, entering a value into memory will not place the 8500A into the offset mode. The offset function cannot be selected in a range lower than the one in which an offset value was placed in memory.

2-45. VDC/ΩZERO

2-46. Zeroing is performed by the 8500A as an automatic operation. Separate zero values may be stored for VDC and ohms functions (provided the ohms option module is installed). Zero values or correction factors are entered by depressing the STORE switch, then the VDC/Ω ZERO switch. The instrument must be in the lowest range (100 mV or 10 Ω). Any internal drift may be corrected for with the zero functon by placing a good quality short on the input terminals (HI to LO) and depressing the STORE switch, then the VDC/Ω ZERO switch.

2-47. CALIBRATION MODE

2-48. The calibration mode may be used to perform two functions: adding an extra digit of resolution (except in the lowest range) and entering calibration factors for each function and range (the optional calibration memory Option –04 must be installed). The CAL switch is accessible through a hole in the front panel. A small plastic cover pops out and hinges down. Using a small screwdriver or similar tool, push the slide switch down to enter the Cal mode. The CAL LED will light to indicate that the instrument is in the Cal mode. The exponent display is used for the extra digit of resolution so the exponents are lost (except the exponent polarity). Placing the instrument in the Cal mode disables the Error Code function. Any function may be selected and if the option is not installed, random readings will be displayed. If the Cal memory option is installed, inadvertently depressing the STORE switch will erase the calibration factor for whichever function and range the instrument was in. Refer to Section 6 for further instructions about the Calibration Memory option.

2-49. STORE and RECALL

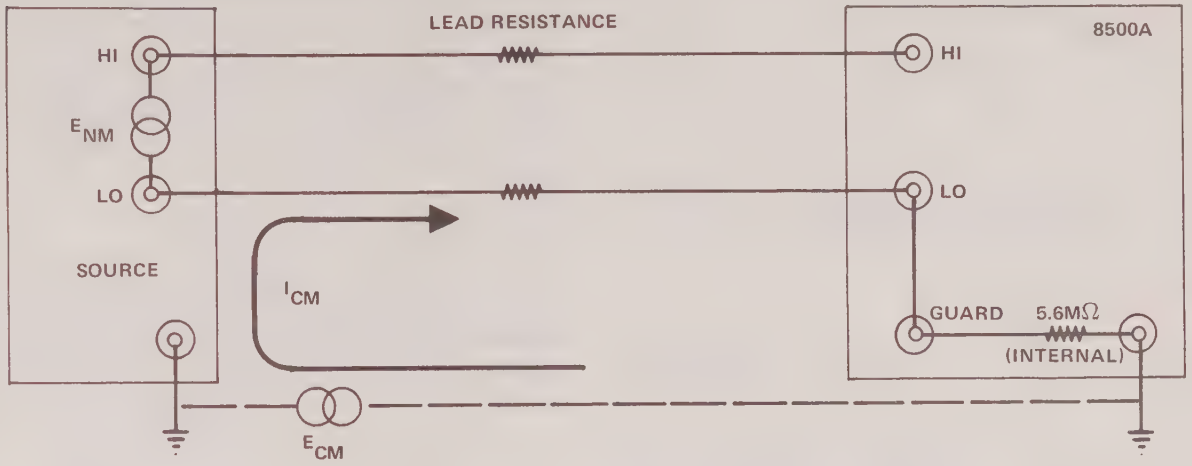
2-50. The STORE switch is used to enter values into memory (Offset, CAL, VDC/Ω Zero) as previously explained. Recall may be used to display a stored value. First depress the RECALL switch, then the desired value switch (OFFSET or VDC/Ω ZERO). Ohms zero values cannot be recalled. The value will be displayed as long as the switch is held depressed. The value displayed will be presented in the resolution of the range the instrument was in when the RECALL switch was depressed.

2-51. Guarding

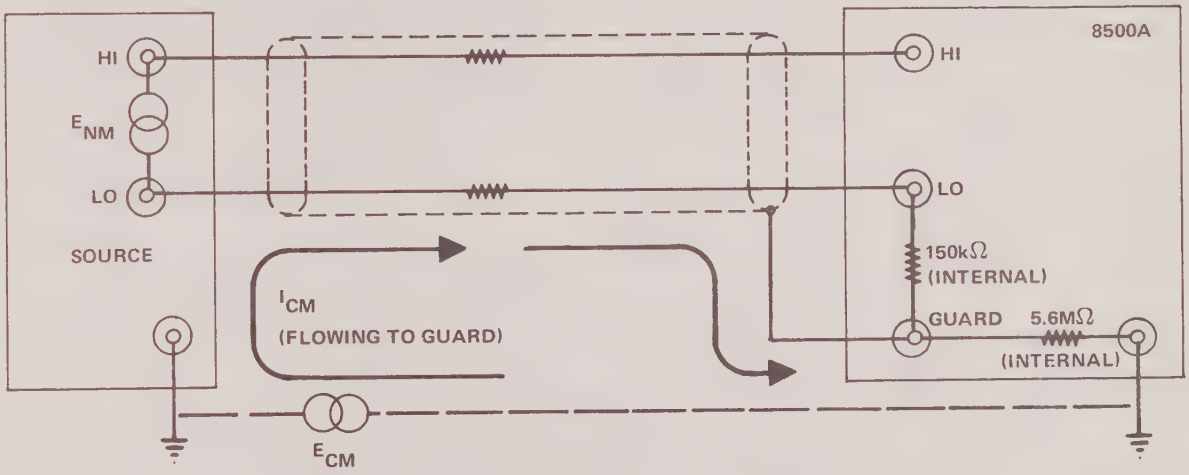
2-52. Common mode voltages are differences in potential that exist between two points that are grounded or common due to voltage drops along the ground wires or to currents induced into them. Normal mode voltages are the voltages and noise of a source to be measured. Common mode voltages may induce current flow through test leads and possibly through the internal impedance of the DVM, producing significant errors. The use of a floating, guarded voltmeter will minimize common mode errors but only if the input and guard connections are made properly. Figure 2-2 shows possible ways of connecting the 8500A to minimize common mode errors. There are two important considerations in using the guard connection. Connect the guard terminal for minimum difference of potential between the guard and input LO terminals. The input LO to guard maximum voltage rating of the 8500A is 100V. Connect the guard to minimize common mode currents flowing through any resistance which helps determine the voltage being measured.

CAUTION

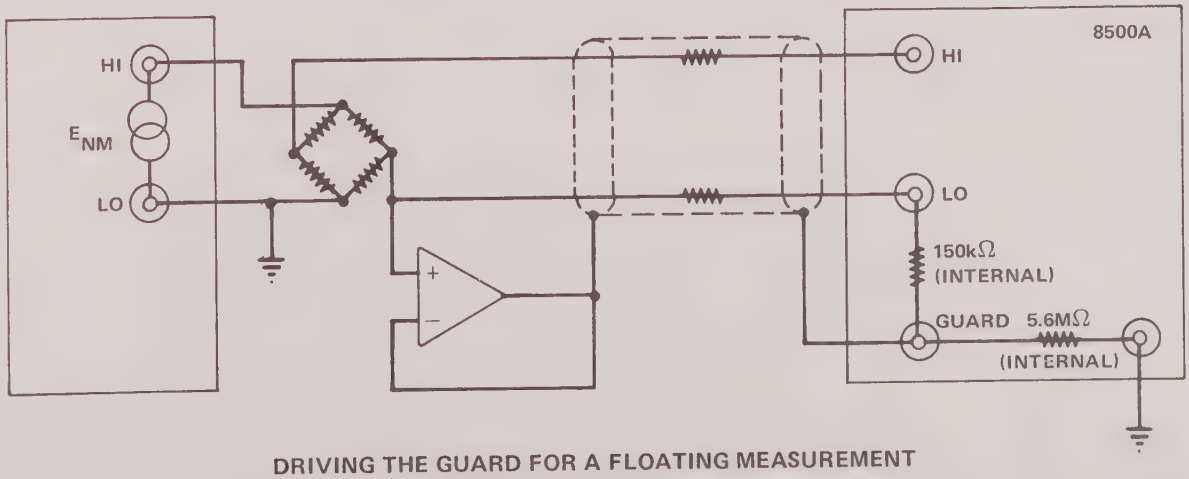
The guard terminal should always be connected either to the input LO terminal or to a point in the source circuit to be measured. With the guard terminal left open, common mode voltages may exceed the input LO to guard breakdown voltage, possibly damaging the instrument.



FOR NONCRITICAL MEASUREMENTS – E_{CM} ERROR PRESENT



E_{CM} ERROR MINIMIZED – I_{CM} FLOWS THROUGH SHIELD INSTEAD OF THROUGH TEST LEADS



DRIVING THE GUARD FOR A FLOATING MEASUREMENT WHICH MAY BE LOADED BY DIRECT CONNECTION OF THE GUARD

Figure 2-2. Guard Connections

2-53. The following conditions are examples of situations in which guarding should be employed:

a. When long signal leads are used.

b. When the signal source impedance is high.

c. When making floating measurements.

d. When making measurements in the presence of high-level noise, such as power line radiation.

2-54. Thermal EMFs

2-55. When making low level, high resolution measurements, the possibility for error due to thermal EMFs should be considered. Generally, thermal EMFs are voltages produced by temperature differences between contacts of two dissimilar metals or by temperature gradients along a length of a material. In some circumstances differences in potential of several microvolts may exist. Input terminals of the 8500A are gold-plated. The use of low EMF, shielded cables with gold-plated spade lugs will minimize thermal EMF errors.

2-56. Systems Use of the 8500A

2-57. Remote interface options are available which will enable the user to interface the 8500A to a large variety of digital systems. All operating and programming instructions relating to remote operation are included in Section 6.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual describes the theory of operation for the 8500A mainframe, which includes the modules necessary for DC Volts and DC Ratio measurements. Block Diagram Description gives an overview of the operation of the modules and an explanation of the bus structure. Circuit Analysis gives a more detailed description of the circuitry. Optional modules are described in Sect. 6.

3-3. BLOCK DIAGRAM DESCRIPTION

3-4. Bus Structure

3-5. The 8500A is constructed with a bus architecture similar to a computer. Figure 3-1 is an overall block diagram of the instrument with optional modules drawn in dashed lines. Figure 3-2 is a block diagram illustrating signal flow. A microprocessor-based controller module controls information flow on the three buses. The controller sets up each of the analog modules for a measurement by addressing the modules as memory locations. An unguarded digital interbus is used to connect the controller to the front panel and to digital option modules such as the calibration memory and a remote I/O (input/output) interface.

3-6. The unguarded digital interbus consists of seven control/address (IC) lines, eight bidirectional data (ID) lines, seven real time (RT) lines, three handshake (INT-interrupt, ACK-acknowledge, INA-interrupt acknowledge) lines, and power supply lines.

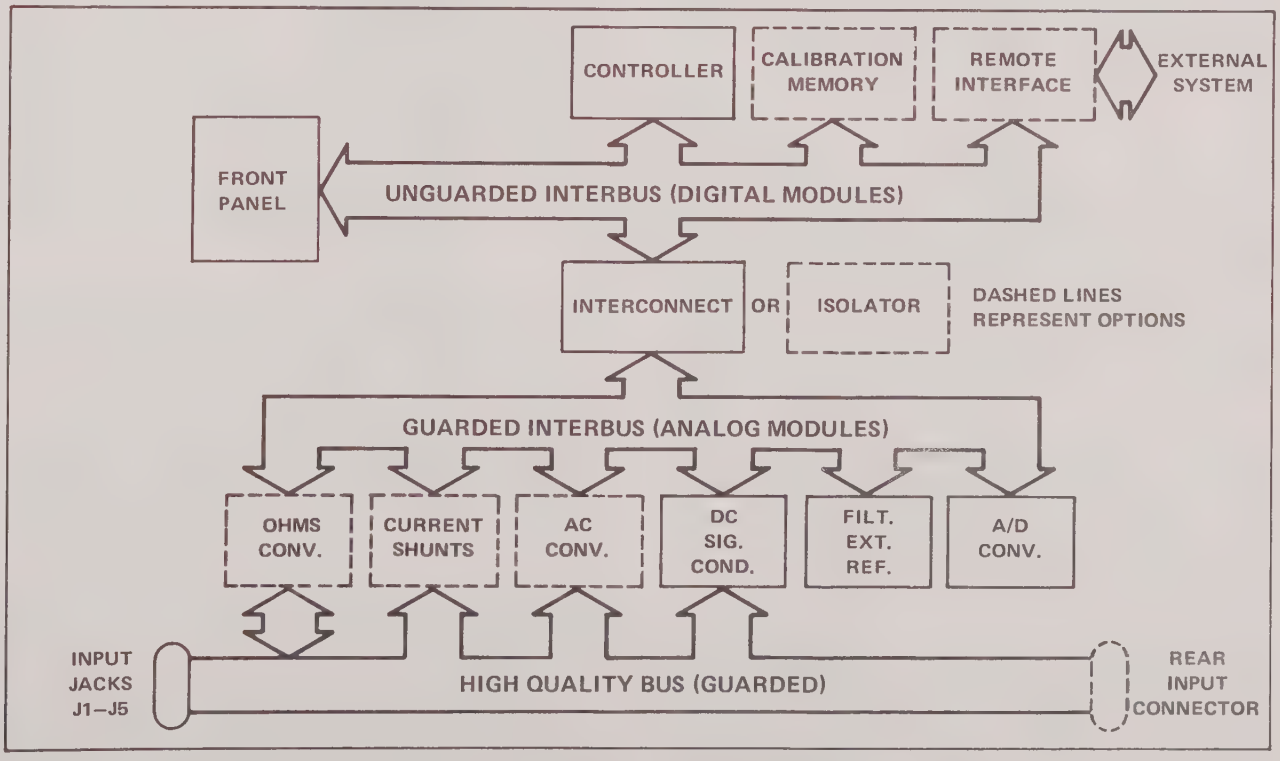


Figure 3-1. 8500A Block Diagram

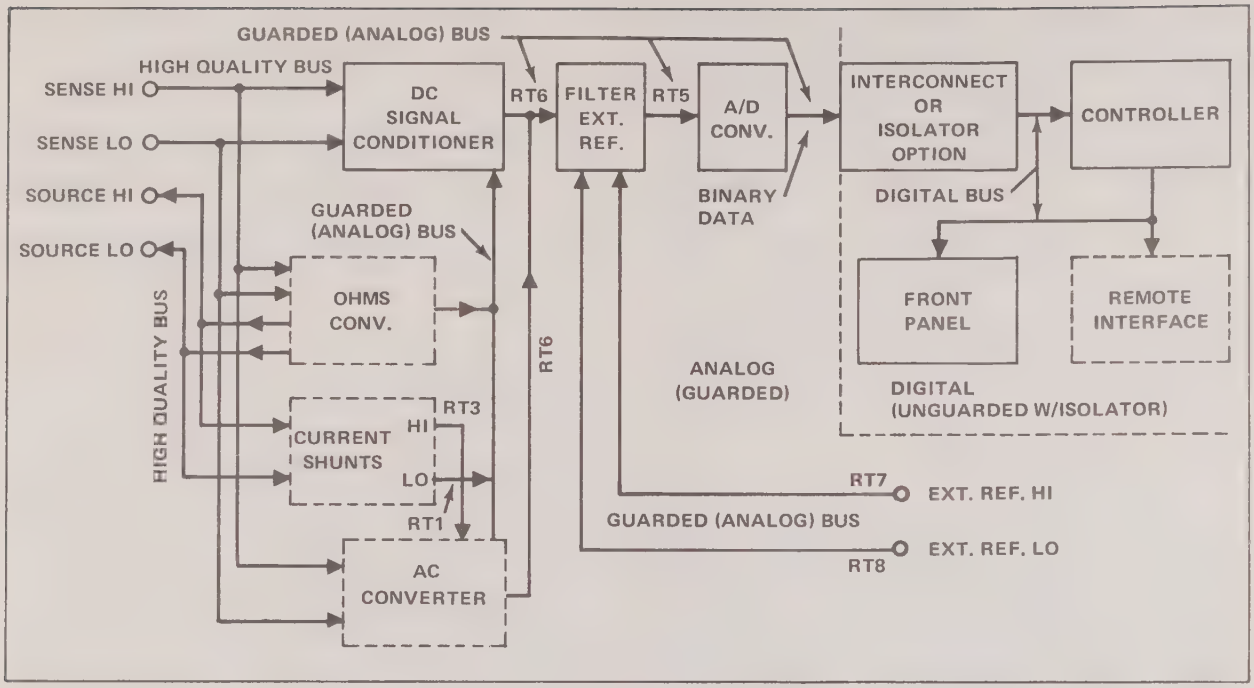


Figure 3-2. 8500A Analog Signal Flow

3-7. A guarded bus connects the controller to the analog modules through an interconnect pcb or through an optional isolator module (must replace the interconnect pcb if an optional remote interface is installed). The guarded bus consists of seven control/address (IC) lines, eight bidirectional data (ID) lines, nine real time (RT) lines, one handshake (ACK) line, and power supply lines.

3-8. The address, handshake, and data lines of the two buses serve the same functions. The real time and power supply lines may have differing functions. For example, the RT lines in the unguarded bus are unused except for RT5 which is the line frequency reference. The RT lines in the guarded bus form an analog bus which carry all the conditioned and converted analog signals between the analog modules. The external reference input lines are part of the analog bus (RT7 and RT8). Logic supply lines (Vcc and Vss) will be different in the two busses if an isolator option is installed. In the guarded bus, Vcc and Vss are always −15V and −20V with respect to analog common. In the unguarded bus with an interconnect pcb installed Vcc and Vss are diode coupled to the guarded bus. But with the isolator option installed, Vcc and Vss are isolated from analog common.

3-9. The third bus is the high quality bus (guarded) consisting of lines connecting the analog input terminals (Input HI and LO, source HI and LO, Guard, Ohms Guard) to the signal conditioning and converting modules. Ohms Guard is available only through the optional Rear Input (−17) connector.

3-10. Controller

3-11. Under the direction of the software program, the controller addresses and sets up each of the modules necessary to perform a function. Two types of addresses are used: direct and indirect. An indirect address requires a previous direct address to set up the indirect address response logic. Data transfers are accomplished with a handshake between the address (IC) lines and the acknowledge (ACK) line. When the controller addresses a module, it places data on the data (ID) lines or receives data from the addressed module. The addressed module must respond with an ACK signal signifying that it is receiving or sending data.

3-12. The controller directs the R^2 A/D converter in taking a sample and receives the sample data from the converter. Range and function information is stored by the controller for application to the data. Using the arithmetic capability of the microprocessor, the software processes the data to arrive at a binary 2's complement number which represents the polarity and value of the measurement. This number is made available to an optional remote interface either as is or after further processing to ASCII code. The number is further processed by the controller for application to the front panel display in a seven segment LED format.

3-13. The software program consists of two parallel processes. A background process (Figure 3-3) is responsible for interrupt driven activities such as updating the display digits and directing the A/D converter in taking a sample.

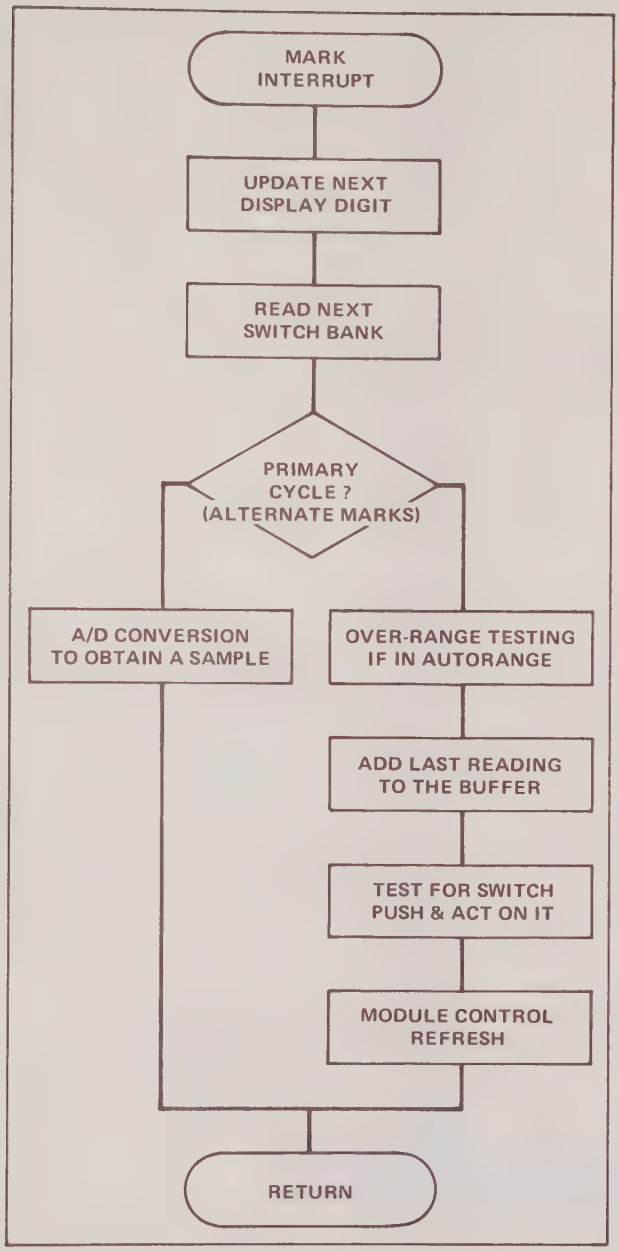

MARK INTERRUPT
UPDATE NEXT DISPLAY DIGIT
READ NEXT SWITCH BANK
PRIMARY CYCLE ? (ALTERNATE MARKS)
A/D CONVERSION TO OBTAIN A SAMPLE
OVER-RANGE TESTING IF IN AUTORANGE
ADD LAST READING TO THE BUFFER
TEST FOR SWITCH PUSH & ACT ON IT
MODULE CONTROL REFRESH
RETURN

Figure 3-3. Background Software Process

The foreground process (Figure 3-4) is responsible for the measurement cycle including accumulating data from the background process and performing required calculations.

3-14. The controller is structured around the Intel 8080 microprocessor. Figure 3-5 is a block diagram of the controller module. Hardware control functions have been minimized by careful software design. Sequences of events are timed from two sources. Basic operations of the microprocessor are run from a 1.7 MHz clock. The other source is generated by shaped line frequency pulses, which are applied to a phase-locked loop. The phase-locked loop multiplies the line frequency by eight. This signal is used to generate mark interrupts which time the background process.

3-15. Software for the 8500A is stored in four ROMs (read only memory). Four RAMs (random access memory) are used for temporary storage of data by the microprocessor. Data lines (DBO-DB7) are used for bidirectional data flow. Address lines (A0-A15) determine the source or storage location of data. Since other modules of the 8500A system are addressed as memory locations, address and data I/O controls are used for access to the external bus structure.

3-16. Interrupts are used to divert the microprocessor from the main program to service other routines. Interrupts are synchronized to an appropriate time in the microprocessor cycle through interrupt control, where assigned priorities vector module identity data onto the data bus. Module identity data words direct the microprocessor to the memory location containing the next instruction. Two interrupts are internally generated: ACK INT and MARK INT (priorities one and six respectively). ACK INT is generated when an acknowledge signal is not returned. MARK INT is used to synchronize A/D samples and display digit updates to the line frequency.

3-17. An interrupt may be externally requested by pulling the INT line low. When the microprocessor is ready to accept the interrupt, the interrupt acknowledge (INA) signal is generated. The requesting module must respond with an ACK and a data bit (on ID1–ID4) which is used as a priority vector by INT CONTROL.

3-18. Two types of resets may occur: software and hardware. Software resets are a result of front panel or remote requests. Hardware resets occur at power up or power down. Line frequency pulses from RT5 are sensed by the reset logic. At power up the reset signal assures that the microprocessor will start from program location zero. At power down the reset signal assures that the controller will not call up wrong modules.

3-19. The microprocessor control logic is responsible for latching up a status word at the beginning of each instruction cycle and for telling the microprocessor when to enter and exit wait states. Microprocessor sequences are divided into machine states (one clock period, 588 nsec), machine cycles (from three to five states) and instruction cycles (from one to five machine cycles). Status words are used to control and synchronize data I/O, memory read/write, and some of the interrupt control signals. The microprocessor must be instructed to enter a wait state after addressing an external module and after being interrupted to allow the external module time to respond.

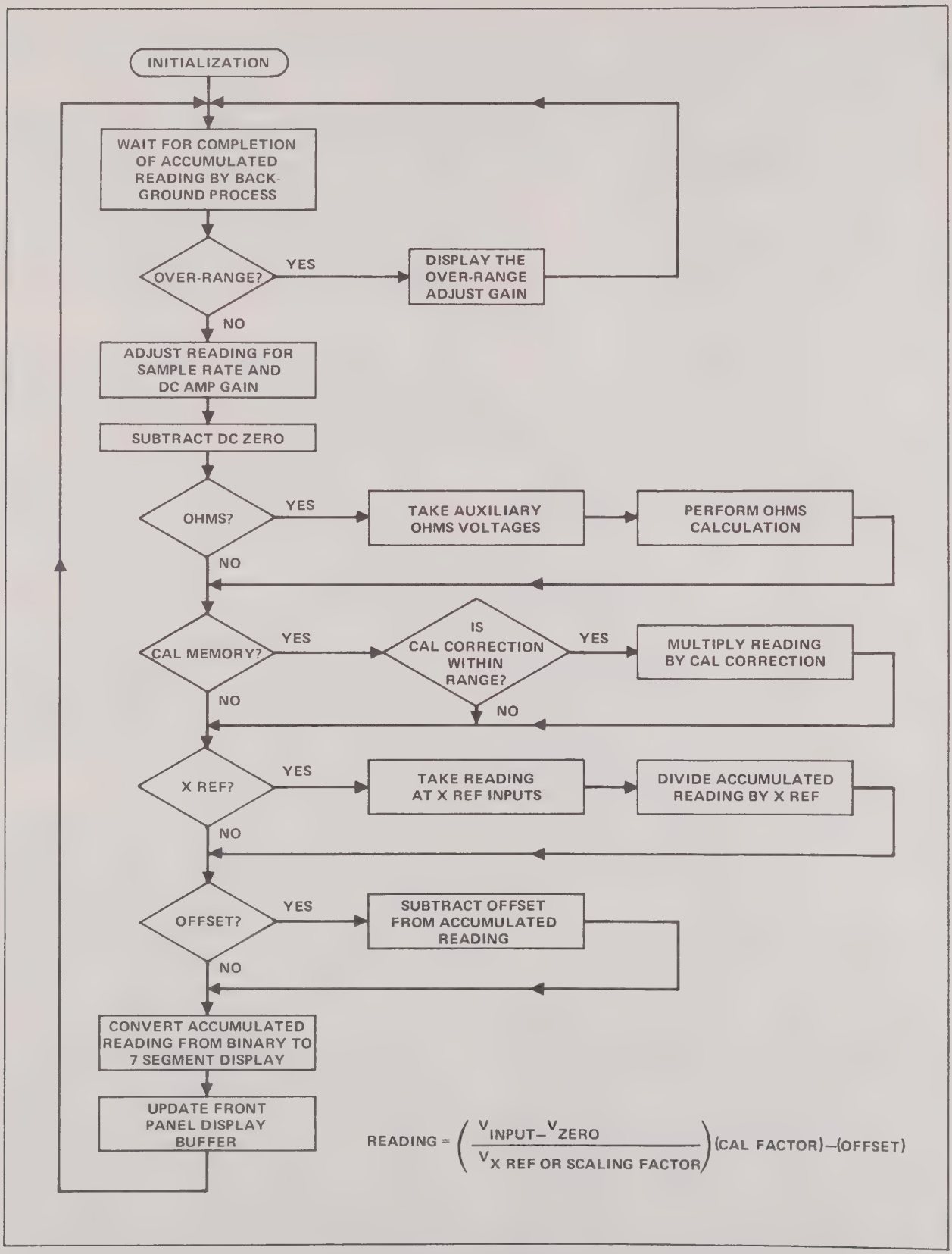


Figure 3-4. Foreground Software Process

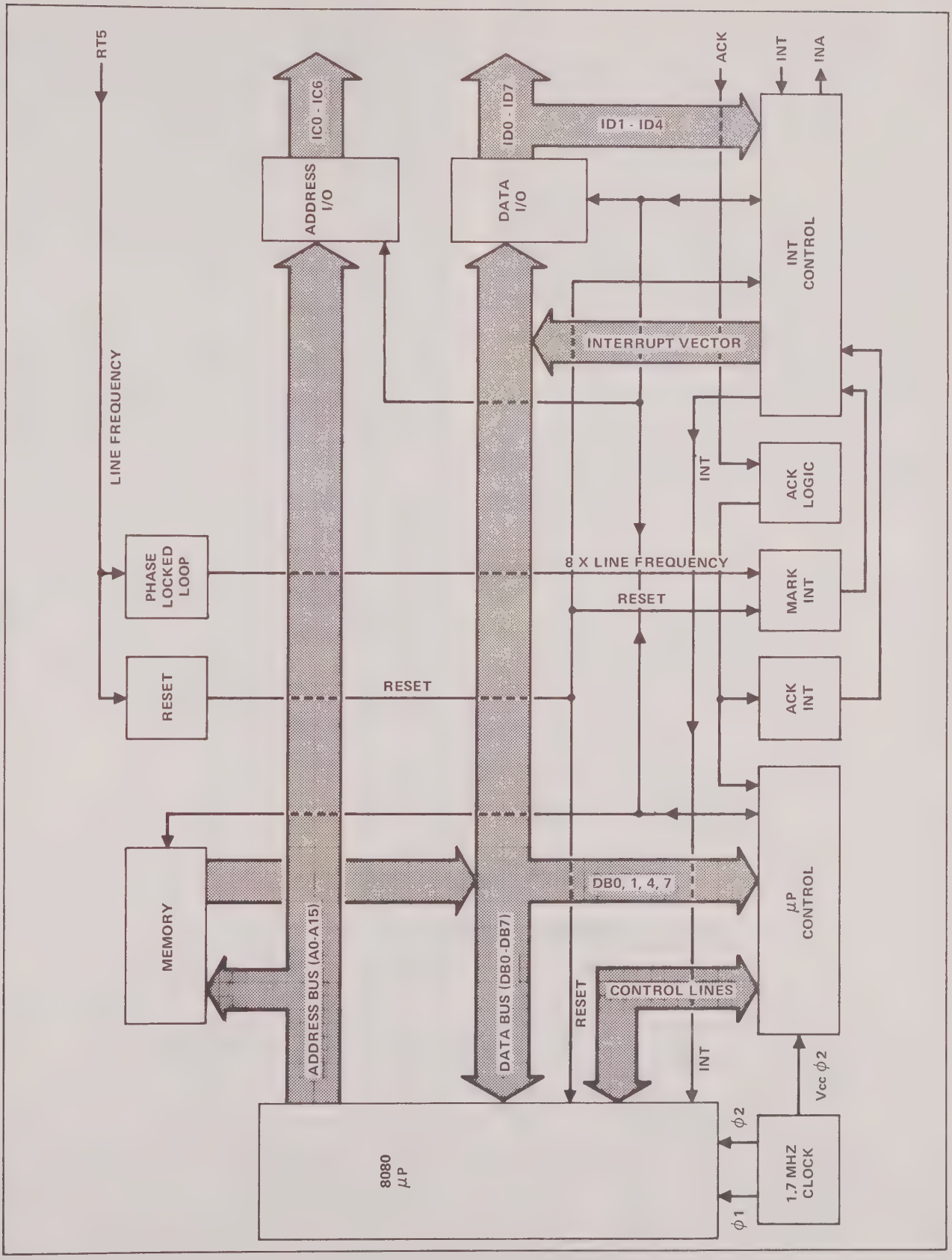


Figure 3-5. Controller Block Diagram

3-20. Front Panel

3-21. The front panel serves as an interface between the operator and the 8500A controller. The display is multiplexed by the controller by means of addressing the front panel for each digit. One direct address, two indirect addresses, and the accompanying data determine which digit or annunciator and which segments will light. An indirect address requires a previous, valid direct address to set up the indirect response. Another direct address enables the switch matrix to be read to determine if any function changes are desired. The cycle of updating each digit and annunciator and reading the switch matrix requires approximately 14 msec and is a continual cycle. Input terminals, J1–J5, are physically located on the front panel but have no electrical interaction with the front panel.

3-22. DC Signal Conditioner

3-23. DC signals from either the input terminals or optional signal conditioners (Ohms or Current Shunts) are routed through the DC Signal Conditioner to be brought within the range of the A/D Converter (± 20V). Figure 3-6 is a block diagram of the DC Signal Conditioner. For ease in arithmetic manipulations in the microprocessor, all gains or attenuations in the 8500A are powers of eight. Gain or attenuation factors are selected by the microprocessor addressing the module. Data from the data bus is latched into the control circuitry and used to select relays in the attenuator and switches in the amplifier feedback circuit. The combination of the attenuator and feedback-controlled amplifier give gain or attenuation factors of one, eight, or sixty-four.

3-24. Active Filter

3-25. The purpose of the Active Filter module is to multiplex dc signals to the A/D Converter and to switch analog filters into the signal conditioner inputs. Figure 3-7 is a block diagram of the Filter/External Reference module. Either the fast or the slow filter may be selected from the front panel. Both filters may be bypassed by

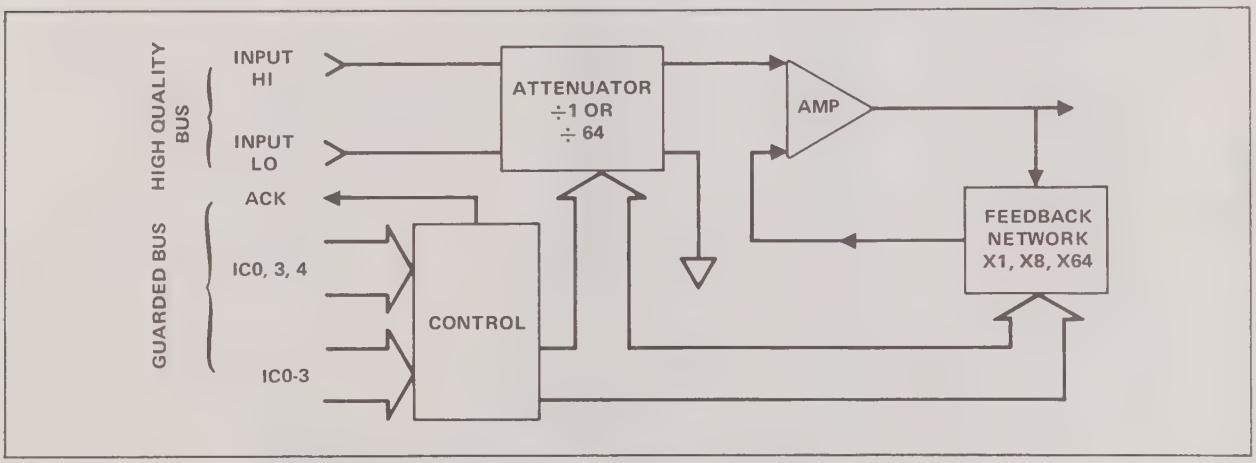


Figure 3-6. DC Signal Conditioner Block Diagram

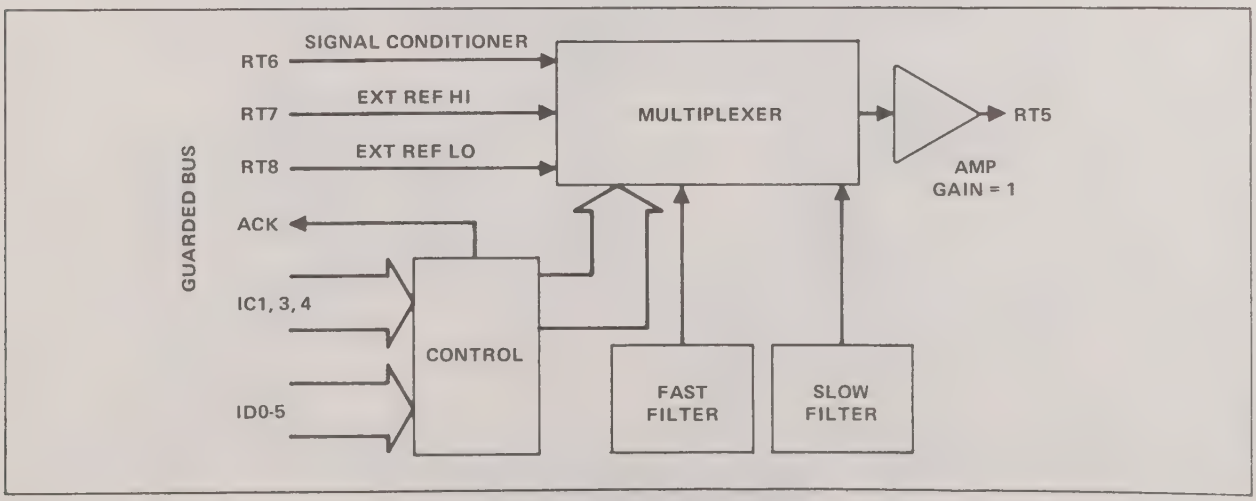


Figure 3-7. Active Filter Block Diagram

command from a remote interface. For external reference measurements, the signal conditioner input, the External Reference HI input and the External Reference LO input are multiplexed to the A/D Converter. Samples are taken of each input and arithmetically manipulated by the Controller to arrive at a reading. Outputs from the optional AC converter modules are applied to the Active Filter module, bypassing the DC Signal Conditioner.

3-26. Fast R^2 A/D Converter

3-27. The Fast R^2 A/D Converter employs Fluke's patented recirculating remainder (R^2) technique for converting a dc input signal into a binary, bit-serial data stream. The R^2 technique has been modified for microprocessor control. Obtaining a sample is a five-step process. Each step consists of a decision period of five decisions and a subtraction period. Set-up of the converter, decisions, and reset are initialized by the Controller addressing the A/D Converter. Figure 3-8 is a block diagram of the R^2 A/D Converter.

3-28. During the first step, the input signal is applied to the Summing Node. The polarity of the input is detected and that bit of information is transmitted to the Controller. On the basis of the returned polarity, the A/D module selects which reference polarity is required—positive for negative inputs, and vice versa. The first of five precision currents is switched into the Summing Node and a polarity bit returned. If the polarity changed, the first current is switched off. If not, it is left on. Then the next current is switched into the summing node and another polarity bit returned. Another decision is made and so on until all five currents have been switched into the summing node and five decisions have been made. This completes the first decision period. The five precision currents are related by powers of two. The fifth current has a resolution of thirty-two.

3-29. Following the decision period is a subtraction period. Feedback through the Remainder Storage nulls whatever remainder was left after the five currents have been switched into the summing node. The remainder is amplified by sixteen by the Remainder Amp and is stored on a capacitor in Remainder Storage. This completes the first step. The input is now switched out of the Summing Node and the amplified remainder switched in for the next step. There are two remainder channels in Remainder Storage and they are alternated in the four subsequent steps. Since the fifth current has a resolution of thirty-two and the remainder amp has a gain of sixteen, the first bit of a step has the same weight as the last bit of the previous step.

3-30. Of the five steps required to complete a sample, the first uses the input signal for decision and subtraction periods. The four subsequent steps alternate remainder channels to use the amplified remainder of the preceding step for decision and subtraction periods. Polarity bits

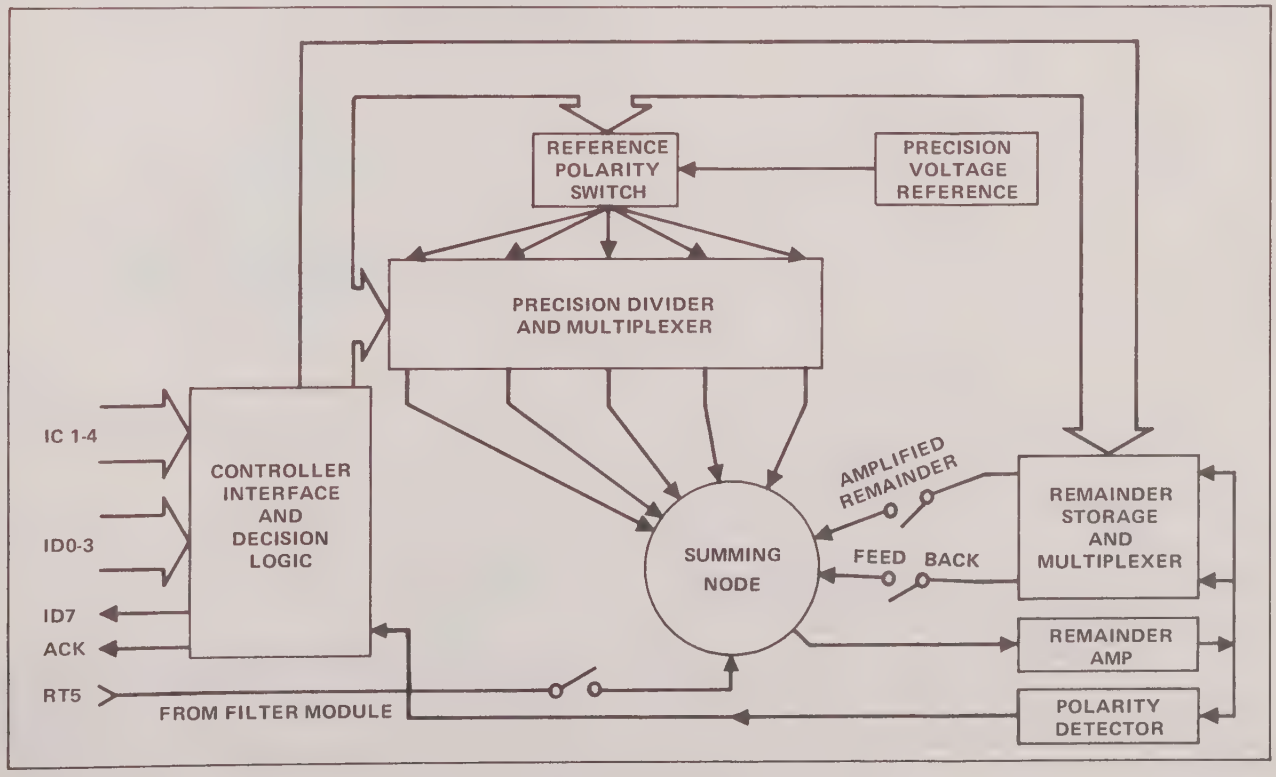


Figure 3-8. R^2 A/D Converter Block Diagram

returned at each decision are accumulated by the Controller and assembled into a 24-bit word describing the polarity and magnitude of the input.

3-31. CIRCUIT ANALYSIS

3-32. Introduction

3-33. The following circuit analyses detail the functioning of the circuitry composing each module in the 8500A mainframe. Optional modules are covered in Section 6. Block Diagram Description should be read first to get an understanding of the overall functioning of the instrument. Simplified schematic diagrams are referred to by figure number. Complete schematic diagrams are located in Section 8 (Section 6 for optional modules). Table 3-1 is a list of mnemonic definitions used in the Controller schematic.

3-34. Controller

3-35. TIMING

3-36. The 8080 microprocessor requires two 12V clock inputs whose phase relationship must fall within certain limits (Figure 3-9). The period of the $\phi 1$ clock (588 nsec) governs the duration of a machine state (3 to 5 states required for a machine cycle, 1 to 5 machine cycles required for an instruction cycle). A 1.7 MHz crystal oscillator is RC coupled through buffers and gates to provide the two-phase clock signal. R1 controls the positioning of the $\phi 1$ clock pulse (with respect to time) during the $\overline{\phi 2}$ pulse. The $\phi 2$ clock pulse is inverted and translated to 5 volt TTL levels for other timing functions in the control circuitry.

3-37. Shaped line pulses are applied to a phase-locked loop (U26) which runs at 8 times the line frequency (480 Hz for 60 Hz line, 400 Hz for 50 Hz line). U34 divides the output of U26 by 8 for application to a phase comparator contained in U26. Line synchronization is achieved using the output of the phase-locked loop to time the internal interrupt, MARK INT.

3-38. ADDRESS and DATA BUSSES

3-39. Sixteen address lines are used for addressing memory locations and external modules. Refer to the Controller schematic in Section 8. A0-A7 are used for internal scratch pad memory locations with A8, 9, 11, 12, 13 decoded as a RAM chip select. A0-A10 are used for internal ROM locations with A11, 12, 13 decoded as a ROM chip select. A14 is used as ROM/RAM select (high for RAM). A8-A14 are used for external addresses with A15 used as external/internal select (high for external). These address lines are inverted when driving the IC lines on the Interbus. The data bus is eight lines (DB0-7) connected directly to memory and to the external data bus (ID0-7) through tristate I/O buffers.

Table 3-1. Mnemonic Definitions

ACK	— acknowledge
ACK LAT	— acknowledge late
AR	— analog return
DB	— data bus
DBIN	— data bus input signal (from μP)
DLD ACK	— delayed ACK
EN INT	— enable interrupt
HLDA	— hold acknowledge
IB ADX	— interbus address
IBIN	— interbus input signal
IC	— interbus control
ID	— interbus data
IINT	— internal interrupt
INA	— interrupt acknowledge (from controller)
INT	— interrupt
INTA	— Interrupt acknowledge (status word from μP)
INTE	— interrupt enable (from μP)
MEM RD	— memory read
MS ADDR BYTE	— memory select address byte
$\phi 1$	— clock pulse
$\phi 2$	— clock pulse
ϕLL	— phase-locked loop
RAM	— random access memory
ROM	— read only memory
RRDY	— reset ready
RST	— reset
RT	— real time
R/$\overline{W}$	— read/$\overline{\text{write}}$
μP	— microprocessor
VA	— analog supply voltage
V_{CC} $\phi 2$	— 5V clock pulse
V_{DD} $\phi 2$	— 12V clock pulse
SRDY	— set ready
SYN IINT	— synchronized internal interrupt
TTL PU	— TTL pull-up
WO	— write out
WR	— write

3-40. RESET

3-41. Shaped line frequency pulses are applied to U36 and U34 to provide a reset on power up or power down (Figure 3-10). U36 is a retriggerable one-shot multivibrator which is cleared on power up by Delayed Vcc. Clearing U36 sets U35 to the Reset condition. After the clear on

U36 is removed (Delayed Vcc high), U34 clocks U35 out of the reset condition on the eighth line pulse. At power down, U36 changes state at a time determined by R18 and C22, setting U35 to the reset state.

3-42. STATUS LATCH

3-43. During the first state of every machine cycle, the microprocessor sends a status word out on the data bus. This is at the same time and duration as the SYNC output. SYNC $\overline{\phi 2}$ clocks the status word into a hex "D" latch, U18. Outputs from U18 (Figure 3-11) are used in various portions of the control circuitry.

3-44. WAIT LOGIC

3-45. When the microprocessor addresses an external module (A15 high) or is interrupted, the WAIT logic causes the microprocessor to enter a wait state by pulling the ready (RDY) line low (Figure 3-12). $\overline{\text{SRDY}}$ is normally high and is pulled low to exit the wait state. RRDY is normally low and goes high to enter the wait state. A15 TTL is high for an external address, so RRDY will go high at SYNC TTL (derived from the microprocessor). For interrupts, the interrupt enable (INTE) signal is inverted for application to U8. INTE enables INT and is removed before INT falls low (due to an RC delay in the INT CONTROL circuit) so that INT and $\overline{\text{INTE}}$ are high long enough to clock U1 for a wait signal.

3-46. Three possible combinations will cause the microprocessor to exit a wait state. If an ACK signal is missing, ACK INT TTL will pull $\overline{\text{SRDY}}$ low. For external addresses, and external interrupts, A15 + INTA and ACK LAT will pull $\overline{\text{SRDY}}$ low. For internal interrupts SYN IINT and

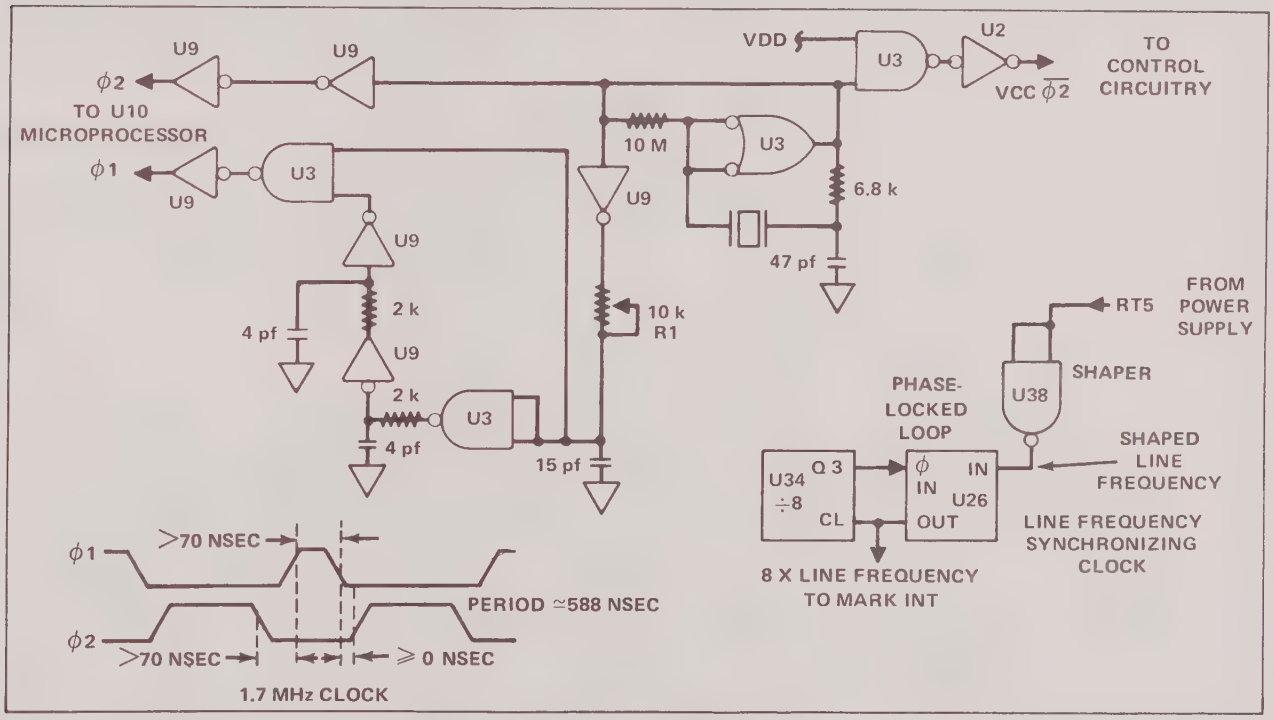


Figure 3-9. Timing Circuits

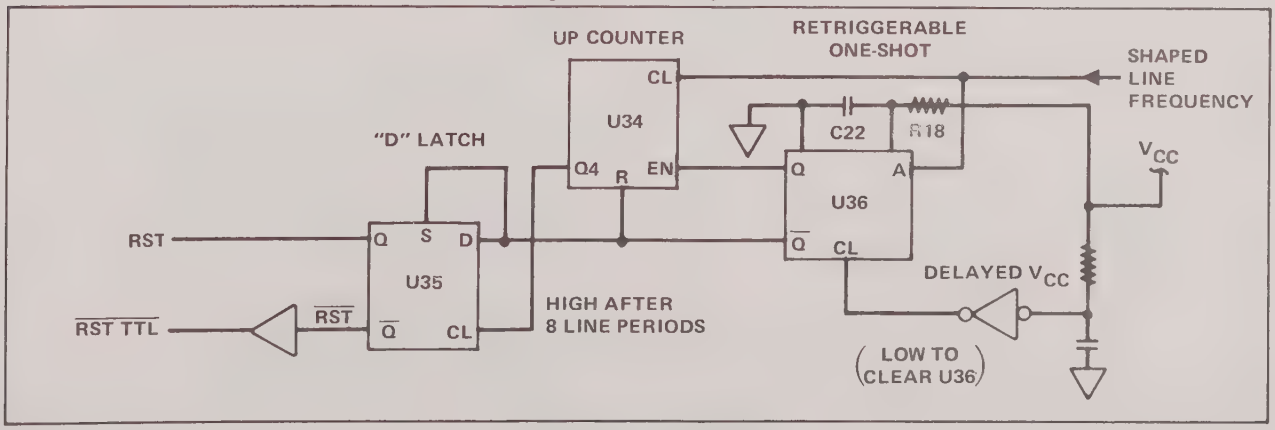


Figure 3-10. Reset Logic

INTA remove the wait state limiting the wait time to a single machine state.

3-47. ACK LOGIC

3-48. When a module is addressed by the Controller, or enabled for interrupt identification by INA from the Controller, it must return an ACK (high) signal. Refer to Figure 3-13. Either INTA (for interrupts) or A15 (for external addresses) together with the delayed ACK signal produce $\overline{\text{DLD ACK}}$ for U38. $\overline{\text{DLD ACK}}$ resets the ACK interrupt logic, which is timing the wait for ACK, and produces the ACK LAT signal through U15 and U27. RRDY must be low to get ACK LAT. This synchronizes ACK LAT to the SYNC TTL signal. ACK LAT (or $\overline{\text{ACK INT TTL}}$ if an ACK is missing) causes the microprocessor to exit the wait state.

3-49. INTERUPTS

3-50. Two internal interrupts and four possible external interrupts are applied to the interrupt (INT) control logic (Figure 3-13). A low on OR gate U17 places a high on NAND gate U38. When INTE is high from the microprocessor (during the last state of an instruction cycle), U38 outputs a low through an RC delay network to U32. U32 inverts the signal and places a high on the INT line to interrupt the microprocessor. The microprocessor drops INTE low, then puts out an interrupt acknowledge (INTA) as a status word which is latched up in the Status Latch, U18. Then the microprocessor enters a wait state until the interrupt and its priority are identified through INT VECTOR, U28 (Controller schematic, Section 8).

3-51. Internal interrupts are ACK INT and MARK INT (Figure 3-14). ACK INT logic consists of a retriggerable

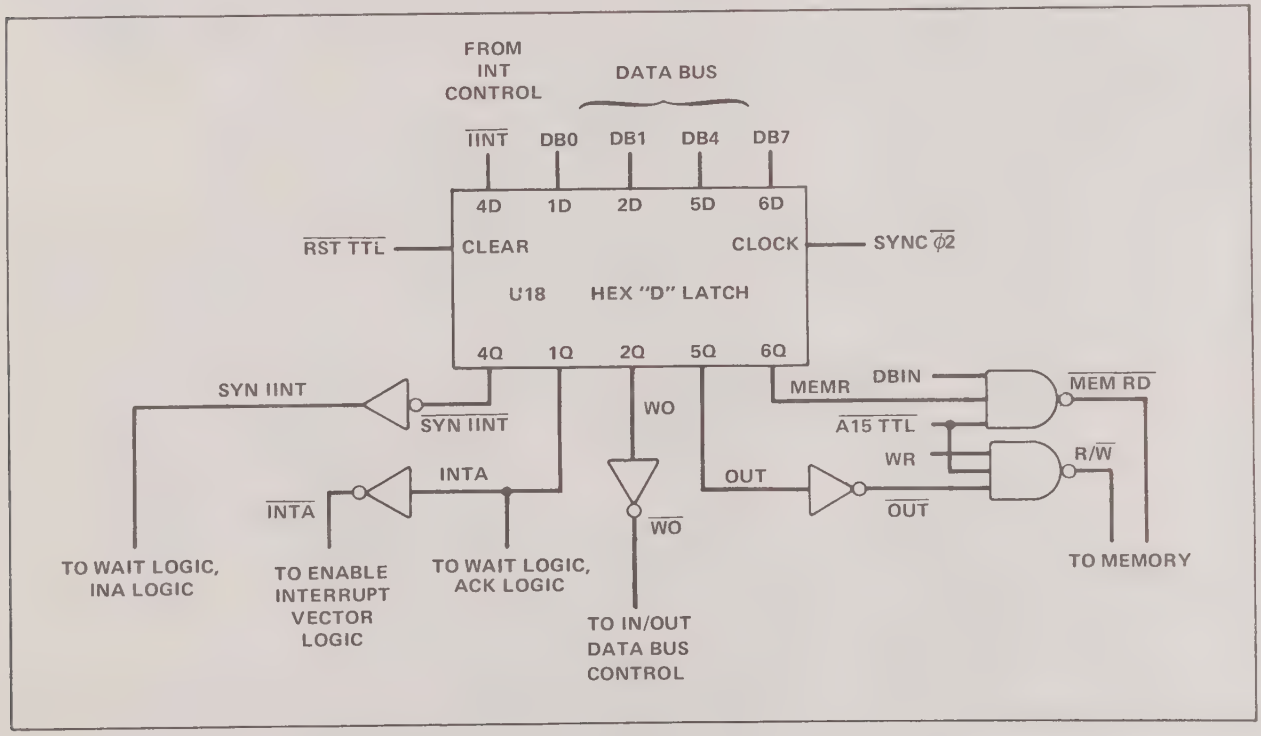


Figure 3-11. Status Latch

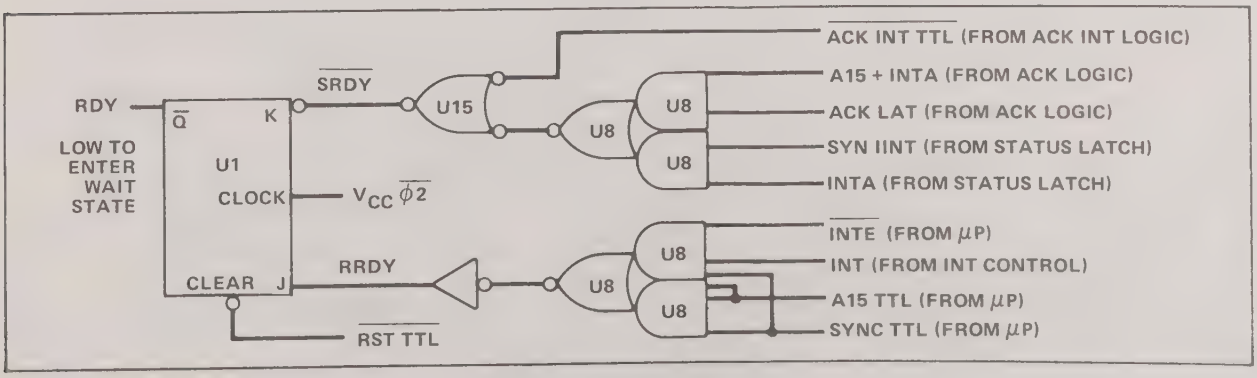


Figure 3-12. Wait Logic

monostable multivibrator, U36, and a "D" type flip-flop, U14. U36 is triggered by A15 TTL and SYNC $\overline{\phi 2}$. If DLD ACK does not occur within the time constant of U36, U36 will clock U14 to generate ACK INT. ACK INT TTL is also generated by U14 to end the wait state resulting from the external address.

3-52. The MARK INT logic is armed by an internal address keyed to RAM. A15 TTL is high indicating an internal address. DB4 is high as part of the status word indicating an address to an output device. A15 TTL and DB4 (both high) with SYNC $\overline{\phi 2}$ clock U1 through U31-12. $\overline{A14}$ is low for a RAM address so U1-7 is clocked high. Although the address which arms the mark is keyed to RAM, no data transfer takes place between the microprocessor and RAM. The write signal (R/$\overline{W}$) is disabled by OUT from the STATUS LATCH. $\overline{MEM\ RD}$ (memory read) is disabled by DBIN (from the microprocessor) and MEMR (from the STATUS LATCH) both being low. After ARM MARK (U1-7) is clocked high, the next pulse from the phase-locked loop timing circuit clocks U14 to generate the MARK INT signal.

3-53. Interrupts are prioritized through INT VECTOR (refer to Controller schematic, Section 8). Before entering a wait state after an interrupt, the microprocessor puts out a DBIN signal, signifying that it is ready to receive data. $\overline{DBIN}$ and $\overline{INTA}$ produce EN INT through U37 to enable the Interrupt Vector (U28). Internal interrupts are applied directly to U28 and have priorities of one (highest) for ACK INT and six (lowest) for MARK INT. For an internal interrupt, $\overline{IINT}$ is generated by one section of U38 (Figure 3-13) and, when latched into the Status Latch (U18), is used to end the wait state. For an external interrupt, SYN IINT is low and with $\overline{EN\ INT}$ low, INA is generated on the interbus. The interrupting module must respond with an

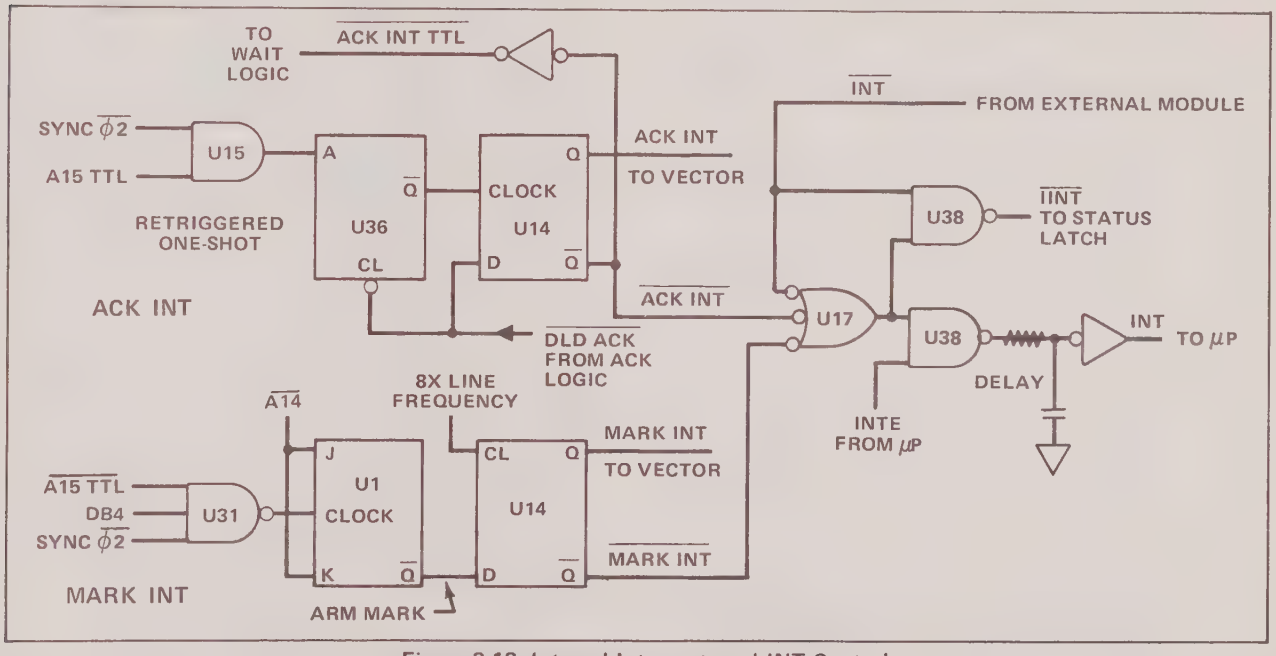


Figure 3-13. Internal Interrupts and INT Control

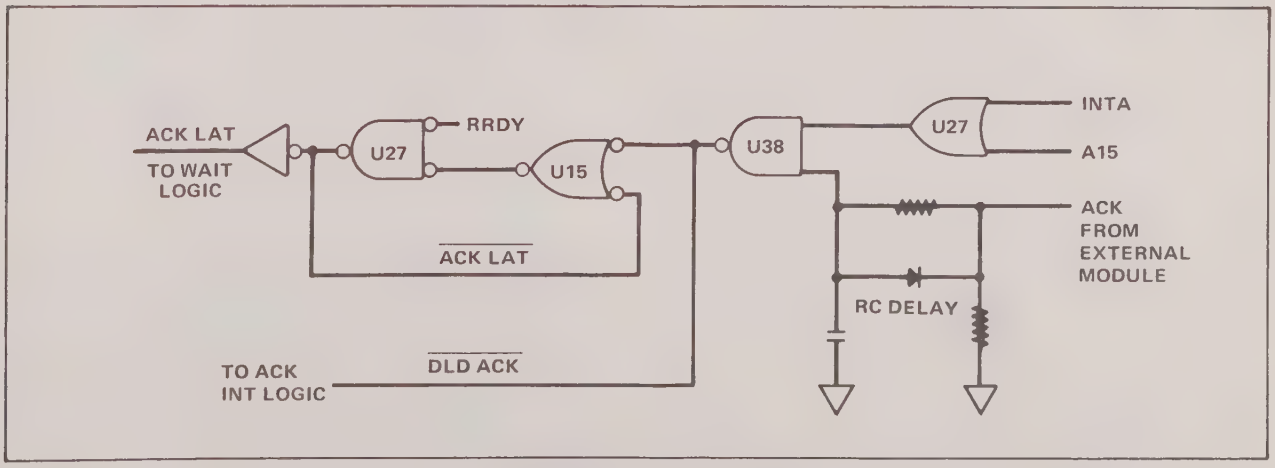


Figure 3-14. ACK Logic

ACK and a data bit on ID1-4. The returned ACK ends the wait state and the data bit is applied to INT VECTOR, U28. The complement of the output from U28 is placed on the data bus to instruct the microprocessor where to go for the next instruction.

3-54. Front Panel

3-55. Annunciator segment data is clocked into register one by the direct address, IC0, 1, 5 high. Refer to Figure 3-15. Data output from the switch matrix is also a direct address–IC0, 1, 6 high. For either direct address, the condition of ID7 (high for disable) is latched into U23 to enable an indirect address. Digit segment address–IC1, 5 high, and digit-annunciator select address–IC0, 5 are both indirect addresses. Data is clocked into the registers upon termination of the address. An update sequence is as follows:

1. Register one is addressed with all data lines low to blank the annunciator display and enable indirect addressing.
2. Register two is addressed indirectly with data lines low to blank the digit display.
3. Register three is addressed indirectly with all data lines high to turn off all LEDs, disable the switch matrix, and disable indirect addressing.
4. Register one is addressed with ID7 low to enable indirect addressing and with annunciator segment data on ID0-6. The data is latched and applied to the annunciator LEDs.
5. Register two is addressed with digit segment data on ID0-7 (U23 is not clocked by this address so ID7 may be high without disabling indirect addressing). The data is latched and applied to the digit LEDs.
6. Register three is addressed with ID7 high (disable indirect addressing) and one of the data lines, ID0-6, low to enable one digit LED and one annunciator LED. One bank of the switch matrix is also enabled.
7. The output buffer is addressed enabling the data from the previously enabled switch bank to be placed on the data bus. One or more lines low indicates a change is desired. This address also keeps the kill circuit charged.

3-56. The seven steps just outlined are required for one digit-annunciator-switch bank update. The process is repeated seven times for a complete update. The kill circuit is used to blank the display if the Controller discontinues addressing the front panel. Otherwise, segments would be left on continuously and would soon burn out.

3-57. DC Signal Conditioner

3-58. Relays K1 and K2 control the input to the DC Signal Conditioner and the attenuation of the input (Figure 3-16). If both relays are energized, the input is from the Volt/Ω input terminals with ÷ 64 attenuation. If just K1 is energized, the input is from the Volt/Ω input terminals with no attenuation. If just K2 is energized, the input is from RT1 (optional signal conditioners). Q10, Q11, CR3, and CR4 provide overvoltage protection.

3-59. Q18 and Q19 are configured as a differential amplifier driving U3. Q14, Q15, and Q16 are FET switches controlling the gain of Q18, Q19, and U3. U4, Q33, and Q37 provide bias for Q18 and Q19. U4 provides a bootstrap effect while Q33 and Q37 are a current sink and source. U5 and U6 provide bootstrapping for U3 and U4. Bootstrapping is used to provide an output voltage swing of ±20V without requiring high-voltage amplifiers.

3-60. The DC Signal Conditioner is addressed by IC0, 3, 4 high. Data on ID0-3 is latched up and decoded to determine which switches and relays will be energized. Figure 3-16 includes an example of the relay driver used to minimize thermal changes in the relays between the on and off states. RC coupling between the decoder and the relay driver provide voltage swings up to 4V or down to 0V to ensure positive relay action. Steady state voltages of 1.45V (off) and 2.75V (on) minimize current differences between the on and off states while maintaining the relay state under all conditions.

3-61. Filter/External Reference

3-62. All inputs to the A/D Converter are routed through the Filter/External Reference module. Refer to Figure 3-17. External reference measurements are made by multiplexing the three Filter module inputs to the A/D Converter. Q18, Q19, and Q20 switch the signal conditioner input, the external reference LO input, and the external reference HI input respectively. Data controlling the switches is latched into U1 upon termination of the address (IC1, 3, 4 high).

3-63. U3 and U4 are configured as three-pole, active Bessel filters having different settling times and cutoff points. Either filter may be selected from the front panel for application to the signal conditioner input. Bypass is automatically selected for external reference inputs or may be remotely selected for signal conditioner inputs. The combination of Q32 Q25, Q23 Q24, or Q21 Q22 is turned on to select a filter mode.

3-64. Q27 is a dual, super-beta transistor in a differential configuration driving U5. Q26 and Q30 are a current source and sink biasing Q27. Q26 draws enough current through R19 to bootstrap the input amplifier, Q27, 5V above the output. Gain of the amplifier is set at one by the combination of R21 and the input resistors. The external reference inputs have additional series resistors located at the rear panel terminals.

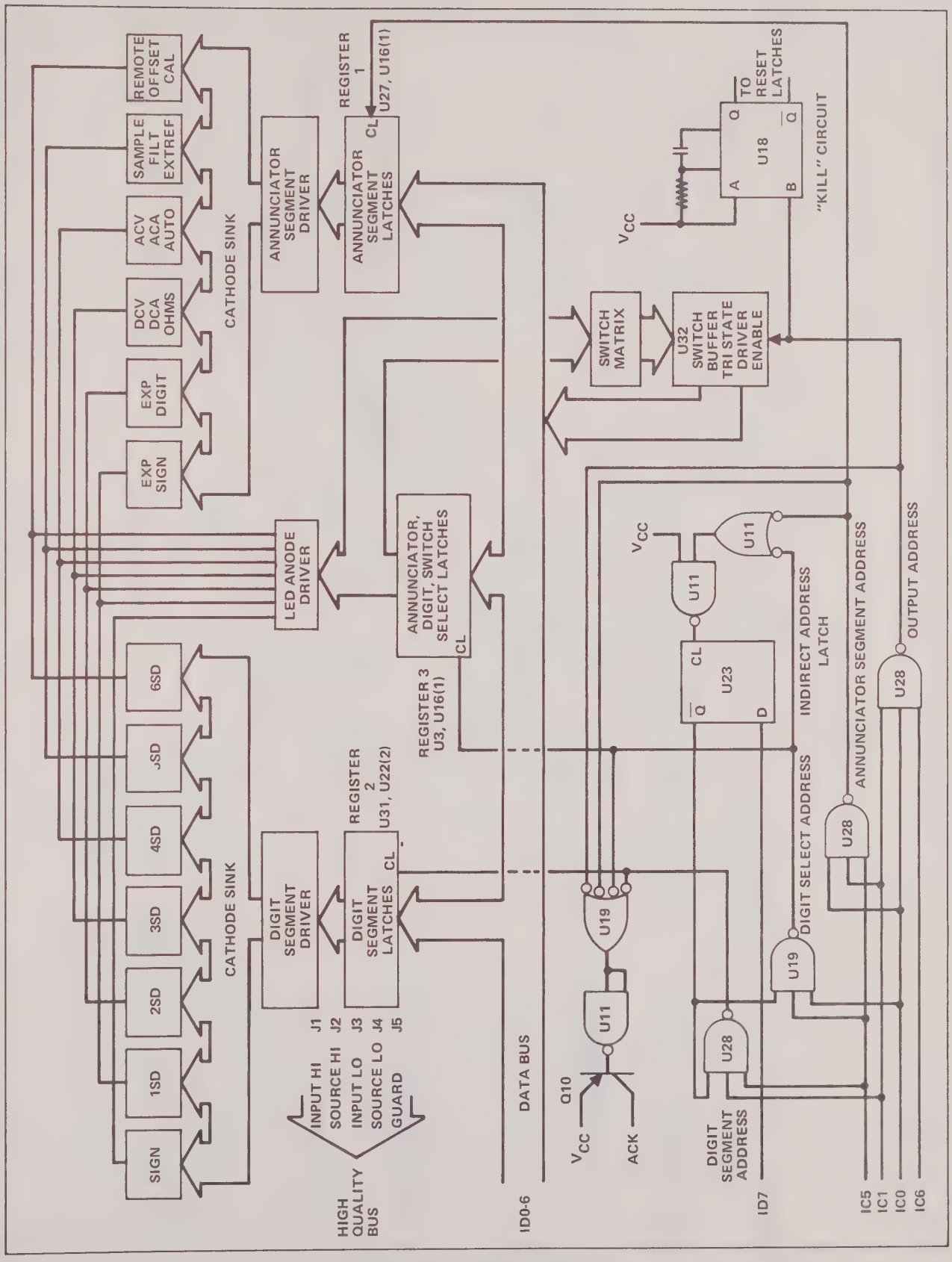


Figure 3-15. Front Panel

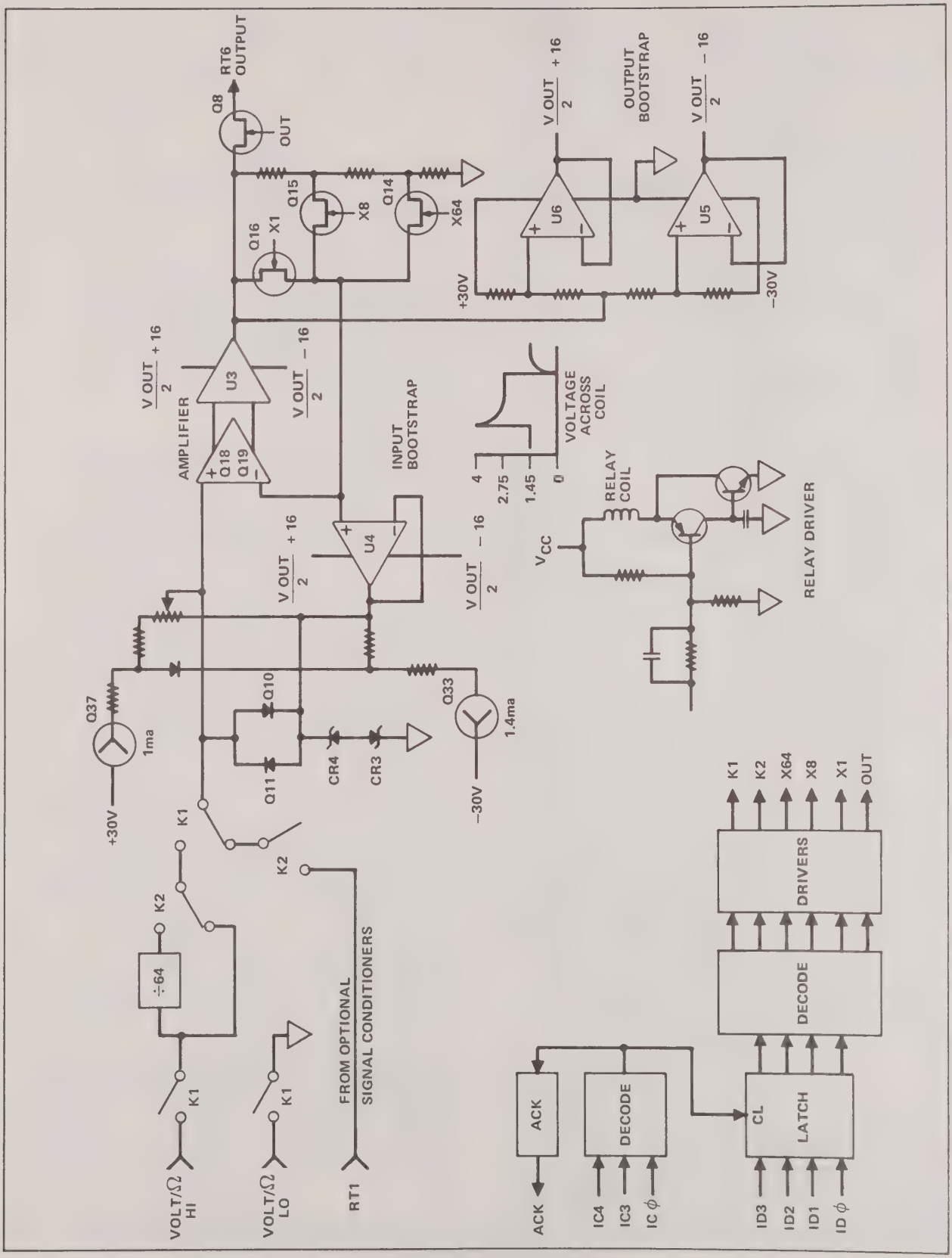


Figure 3-16. DC Signal Conditioner

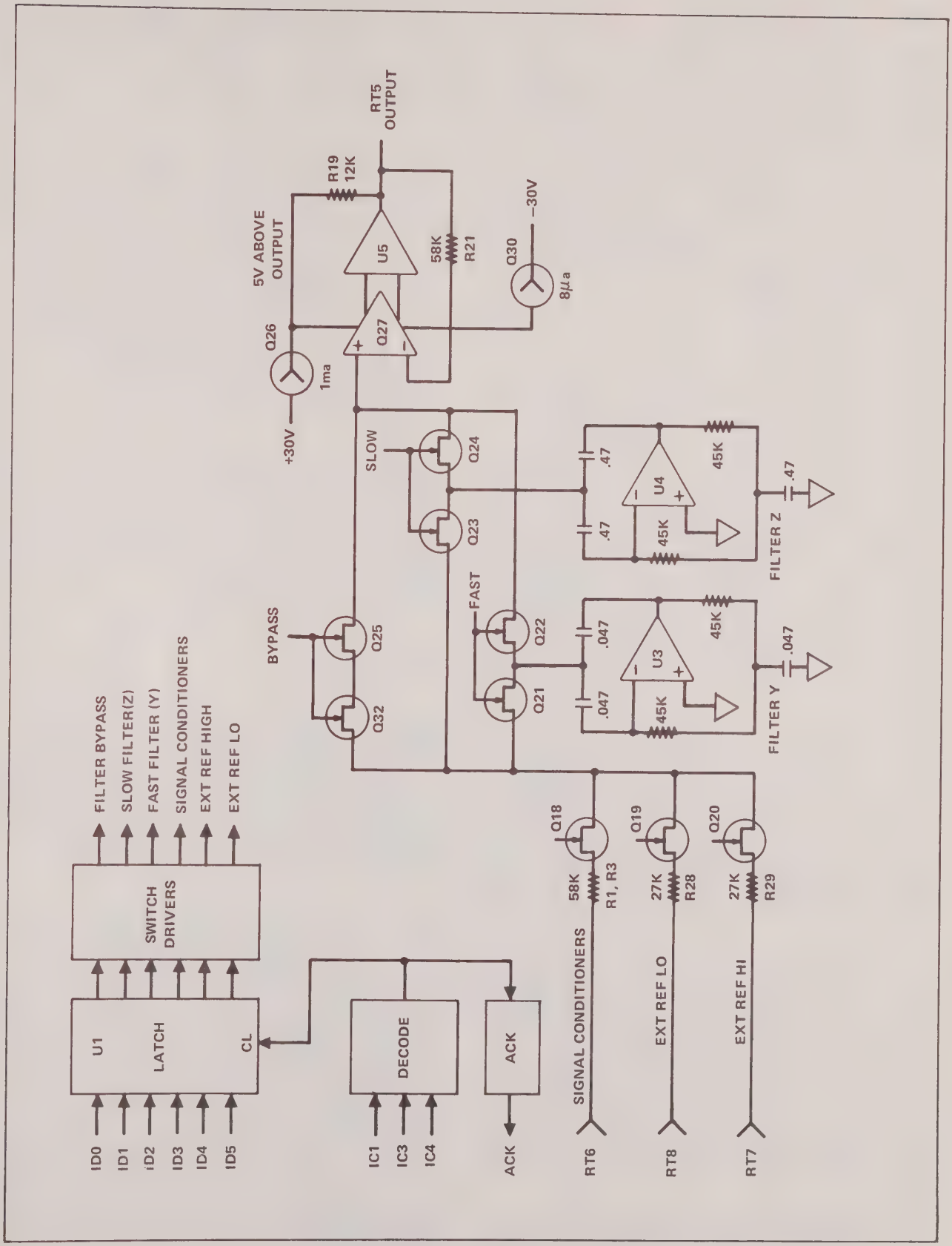


Figure 3-17. Filter/External Reference

3-65. Fast R^2 A/D Converter

3-66. The Fast R^2 A/D Converter may be separated for analysis into two component groups: Analog and Digital. Analog circuitry is responsible for producing a voltage reference, for summations, and for remainder amplification and storage. Digital circuitry interfaces the analog circuitry to the Controller and is responsible for reference selection, decisions in the summation process, remainder channel control, and autozeroing. Since functions within the A/D Converter are either directly controlled by the Controller module via the data bus or are clocked through their operations by the Controller addressing the A/D module, the A/D conversion program could be considered a functional part of the A/D Converter.

3-67. ANALOG

3-68. Figure 3-18 is a simplified schematic of the analog portion of the A/D Converter. For clarity, switches are shown as a circle enclosing a letter designator. U1 is a reference and reference amplifier controlling U2, a current source. The –7V reference is set by R9 and R14. U3 serves as a highly regulated collector and zener supply for U1. Operation of the D/A Converter requires both a positive and negative reference (for negative and positive inputs, respectively). Q9 and U4 are a precision unity gain amplifier whose input is controlled by switches A1 and A2. With A1 open and A2 closed, Q9 and U4 are configured as an inverting amplifier producing a positive reference. With A1 closed and A2 open, Q9 and U4 are a noninverting amplifier.

3-69. An input signal is applied to the summing node of the remainder amplifier (Q27, U7) through switch I. Q27 and U7 are an inverting amplifier with two gain configurations. During the decision period, switch G is closed, applying the output of U7 to polarity detector Q28 and forming a feedback path through CR5 and CR6. Q28 sends a polarity bit to the digital portion of the circuitry. On the basis of this first polarity bit, a reference polarity is selected.

3-70. Switches B, C, D, E, and F are closed, one at a time, to switch a precise amount of current into the summing node. When a switch is closed, the opposite switch is opened and vice versa. For example, when D is closed, $\overline{D}$ is opened. After a switch is closed, a polarity bit is returned. If the polarity changed with respect to the original polarity selected for a step, the switch is opened; otherwise it is left closed. The next switch is closed, a polarity bit returned and a decision made, and so on until all five switches have been closed (and possibly opened again). This constitutes a decision period.

3-71. Following the decision period is the subtraction period. Switch G is opened and switches X and SX are closed to form a feedback path for the remainder amplifier through the X channel. A 400K resistor, R35, sets the gain of Q27 and U7 at sixteen. The feedback current completes the summation process and the amplified remainder is stored on C10 in the X channel.

3-72. For the next decision period switches SX and X are opened and switches RX and G are closed. Since Q27 and U7 form an inverting amplifier, the opposite polarity reference (from the original selection) is automatically selected. The amplified remainder is applied to the summing node through U6 and R34. Five decisions are made, followed by a subtraction period using channel Y for feedback and remainder storage. The first decision-subtraction period applies the input signal to the summing node. The four following steps apply an amplified remainder, alternating between channel X and channel Y.

3-73. When a sample is complete, the circuits are autozeroed. U8 zeros the remainder amplifier through channel X. Any offset is stored on C13 at the noninverting input of Q27. The switching reference, Q9 and U4, is zeroed by first closing A1 and opening A2 to decrease settling time. Then A1 and A2 are both opened and the Z1 and Z2 switches are closed, storing any offset error on C5.

3-74. DIGITAL

3-75. For the following discussion, refer to the Digital Fast R^2 A/D schematic in Section 8. Direct address IC2, 3, 4 latches data into U34 and U35 controlling input switch I, remainder channel switches, autozero, and reset (digital). U31, a ring counter, is clocked to the C1 state enabling the indirect address decoder (U33) and the polarity detector (switch G). A polarity bit is returned and applied to U6.

3-76. Indirect address IC1, 2 latches the polarity bit in U6, enables the tristate transmitter, U5, and clocks U31 to the C2 state. The transition of U31 from C1 to C2 clocks the polarity into U11 (the uppermost section) whose output determines whether switch A1 or A2 will be closed (reference polarity). At the same time, U1 (uppermost section) is clocked to set the other section of U11, closing the first reference switch, B, of the D/A Converter. The next indirect address clocks a new polarity bit (a result of closing the first reference switch B) into U6. If the polarity changed, the output of U6 will cause a reset of the previous switch latch, opening the previous switch. At termination of the address the next switch is closed. One direct address and six indirect addresses are required to complete a step. The last indirect address resets the control logic to the C0 state.

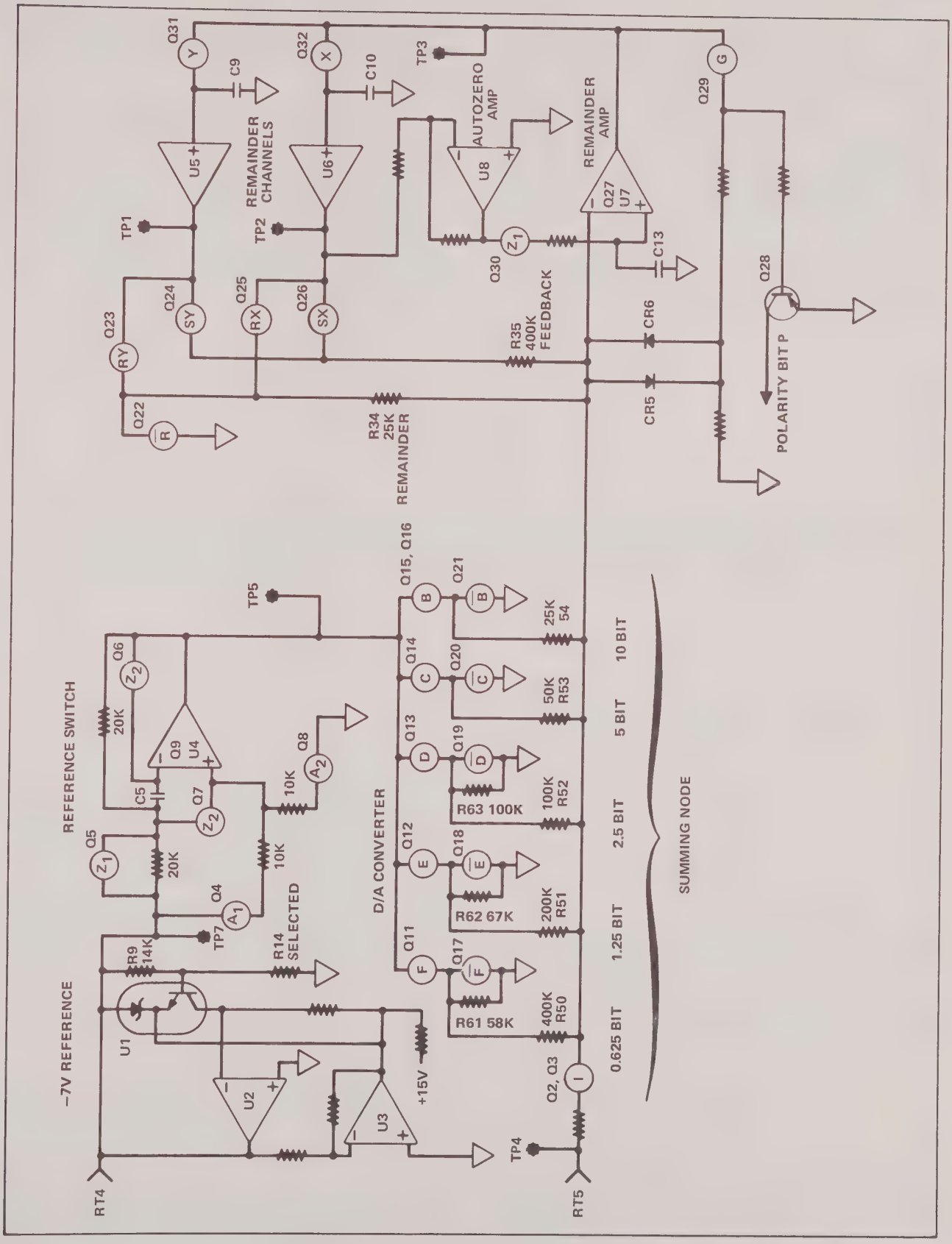


Figure 3-18. Fast R^2 A/D Converter (Analog)

3-77. Switch selections are made through switch drivers which rely on Vcc and Vss being at −15V and −20V with respect to analog common. This allows simple transition from TTL levels to FET off voltages. D/A Converter switches are selected on transition of U31 from one state to the next. The transition clocks the first of two "D" flip-flops which sets the second. The output of the second latch resets the first and selects the switch. If the polarity does not change after closing a switch, the output of U6 plus the output of U11 (reference select) will place two highs on the input of one section of AND gate U25. Through OR gate, U16, a one will be applied to the D input of that switch latch. The next transition of U31 will clock the latch, keeping the switch closed. If the polarity had changed, a zero would be applied to the D input, opening the switch.

3-78. After the last step, at completion of a sample, the Controller addresses the A/D Converter for autozero. U31 is clocked to the C7 state causing a digital reset. When U6, storage capacitor disable, is reset, autozero is enabled. RC coupled gates delay the zero switch controls so that switch A1 may be closed and A2 opened in the reference switching circuit. This provides a faster settling time for the reference switching amplifier. Both A1 and A2 are opened during the autozero time.

Section 4
Maintenance

WARNING!

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains performance tests, calibration procedures, and maintenance information including general maintenance and troubleshooting. Calibration intervals may be determined by the user according to the accuracy desired (specifications are listed in Section 2). One year is the recommended maximum calibration interval. Test equipment recommended for performance tests, calibration adjustments, and troubleshooting is listed in Table 4-1. If the recommended equipment is not available, equipment of equivalent specifications may be used.

4-3. SERVICE INFORMATION

4-4. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located at the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. A complete list of domestic service centers is located in Section 7 of the manual. Shipping information is given in Section 2. If requested, the customer will be provided an estimate before any work begins on instruments that are beyond the Warranty period.

4-6. GENERAL MAINTENANCE

4-7. Line Voltage Selection

4-8. Input line voltage is switch selectable between 115V ac and 230V ac (check Section 2 for line voltage and frequency limitations). Removal of the top cover of the instrument allows access to the switch, located in the left front corner on the power supply board. Turn off the power and disconnect the line cord before removing the cover.

4-9. Fuse Replacement

4-10. The line fuse is located on the rear panel of the instrument near the heat sink. Use an MDL ½A fuse for replacement. The current protection fuse is located on the front panel near the input jacks. Use an AGC 1½A fuse for replacement.

CHECK ERRATA

Table 4-1. Test Equipment

NOMENCLATURE	MINIMUM USE SPECIFICATIONS	RECOMMENDED EQUIPMENT
DC Source	High Short-Term Stability Range: 0 – 1100V	Fluke Model 335A
Null Detector	10 μV Full-Scale Resolution	Fluke Model 335A
Reference Divider	±.001% Division Accuracy	Fluke Model 750A
Kelvin-Varley Divider	Linearity: ±.1 PPM of Input	Fluke Model 720A
Standard Cell Enclosure	Guildline 91	Guildline 9152 (R)
Oscilloscope	General Purpose with 10MΩ Probe	Tektronix 465
Digital Multimeter	Voltage Accuracy: .01% Input Impedance: 1000 MΩ	Fluke Model 8800A
Low EMF, Shielded Connector Cables	Gold-plated Spade Lug Connectors	
Extender Card		Fluke Model MIS-7011k
Bus Monitor		Fluke Model MIS-7013k
AS REQUIRED BY INSTALLED OPTIONS		
AC Calibration System	Voltage Range: 0 – 1000V ac Frequency Range: 10 Hz – 300 kHz Accuracy: 10 Hz – 30 Hz: .1 % 30 Hz – 20 kHz: .02% 20 kHz – 100 kHz: .05% 100 kHz – 300 kHz: .33%	Fluke Model 5200A with Fluke Model 5215A or with Fluke Model 5205A
Current Calibrator with 200 kΩ Resistor	Accuracy: ±.02% ±.01 %	Fluke Model 382A
Standard Resistors	10Ω at 30 ppm; 100Ω, 1.9kΩ, 10kΩ, 100 kΩ, 250kΩ, 1 MΩ, 4 MΩ at 10 ppm; 10 MΩ at 50 ppm; 100 MΩ at 100 ppm	ESI SR-1010 ESI SR-1050
Terminating Load	1 MΩ ± 10%/0.22 μf Nonpolarized Parallel Load	

4-11. Module Installation and Removal

4-12. Use the following procedure to install or remove modules in the 8500A.

1. Turn off the power and disconnect the line cord.

2. Remove the top cover from the instrument.

3. To install a module, select a slot according to Figure 8-2, which shows the permissable and preferred slots for each module. Slide the module vertically between the module guides and press firmly into place.

4. Open the hinged module top. Make sure the spring guard connection is resting on the guard shield (connecting one half of the guard shield to the other).

5. To remove a module, grasp the module at either end and pull up. An end-to-end rocking motion may be used to free the module from the connector.

4-13. Front Panel PCB Removal and LED Replacement

4-14. To remove the Front Panel PCB from the instrument for troubleshooting, repair, or LED replacement, use the following procedure:

1. Ensure that the power is removed from the 8500A.
2. Remove any shorting links from the input terminals.
3. Snap the bezel loose from the frame and remove it from the instrument.
4. Remove any defective LEDs from their sockets and replace.
5. If only LED replacement is required, reassemble in the reverse order. If removal of the Front Panel PCB is required, remove the top covers, remove the pcb retainer from the instrument, then unplug the front panel pcb from the motherboard and remove it from the instrument through the front framework.
7. Reassemble the Front Panel in the reverse order.

4-15. Power Supply Removal

4-16. Remove the Power Supply from the 8500A using the following procedure:

1. Ensure that the power is removed from the 8500A. Remove the top cover.
2. Remove the four screws positioned around the heat sink that secure the power supply to the rear frame.
3. Pull the Power Supply straight back, using a gentle rocking motion to disconnect it from the card edge connector on the interconnect pcb.
4. Reassemble in the reverse order.

4-17. Power Supply Interconnect PCB Removal

4-18. Remove the Power Supply Interconnect pcb from the 8500A using the following procedure:

1. Remove the Front Panel pcb as described above if not already done.
2. Remove the three screws securing the interconnect pcb to the framework.
3. Disconnect the pcb's card edge connector from the power supply and from the motherboard card edge connector. Lift the pcb out through the front framework, taking care not to damage the power switch.
4. Reassemble in the reverse order.

4-19. Motherboard PCB Removal

4-20. Remove the Motherboard PCB from the 8500A using the following procedure:

1. Remove the modules, the front panel pcb, and power supply interconnect pcb from the instrument if not already done.
2. Remove the eight screws that secure the motherboard to the bottom framework and lift the motherboard out through the front framework of the instrument.
3. Reassemble in the reverse order.

4-21. Cleaning Instructions

4-22. Periodically (at least every 90 days) clean the 8500A using the following procedure:

1. Ensure that the power is removed from the 8500A.
2. Remove the top and bottom covers from the instrument.
3. Disconnect the modules from the motherboard and remove them from the instrument.
4. Clean the interior of the 8500A using low pressure clean dry air or a vacuum cleaner.
5. Clean the front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened with a mild solution of detergent and water.
6. Replace the modules and covers if access to the instrument interior is no longer required.

4-23. PERFORMANCE TEST

4-24. Introduction

4-25. The following paragraphs contain a Performance Verification Test which compares the operation of the instrument to the specifications in Section 1 of this manual. The test may be used to verify calibration of the equipment between scheduled calibration periods or as an aid in troubleshooting.

4-26. The test equipment required for the Performance Test is listed in Table 4-1. If the recommended equipment is not available, replacements with equivalent specification may be substituted.

4-27. If the instrument does not meet the specifications listed in the Performance Test, either the calibration procedure or corrective maintenance should be performed, as determined by the symptoms. The test should be performed when the ambient temperature is between 18° and 28° Celsius and the relative humidity less than 75% to attain maximum accuracy.

CHECK ERRATA 2

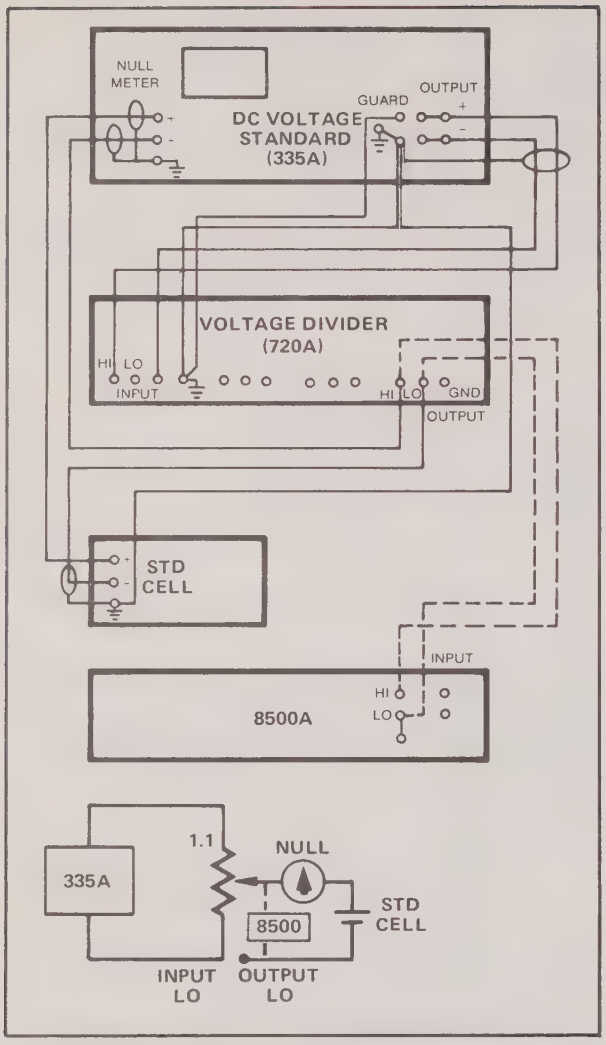


Figure 4-1. Connections For Low Range DC Voltage Tests

4-28. DC Performance Test

4-29. LOW RANGE DC VOLTAGE TESTS

4-30. Perform the Low Range Tests as follows:

1. Connect the equipment shown with solid lines in Figure 4-1. Do not connect the 8500A at this time.

2. Verify that the test equipment is operating properly and their respective warmup periods, as stated in the applicable manuals, have expired.

3. Verify that the 8500A warmup period of one hour has elapsed. Ensure that the VDC and AUTO indicators are illuminated, the SAMPLE indicator flahses approximately eight times per second (32 samples per reading), and all other indicators are extinguished.

4. Set the Voltage Divider controls for one-tenth the standard cell certified value. Adjust the DC Voltage Standard output for a null on the null meter.

5. Disconnect the leads at the Voltage Divider output terminals and connect the 8500A as shown with the broken lines in Figure 4-1.

6. Perform the test listed in Table 4-2, setting the Voltage Divider to the listed outputs. Do not change the output setting of the DC Voltage Standard. After voltage has been applied to the 8500A, but prior to the first reading, toggle the instrument into manual ranging.

7. Reverse the leads at the 335A output terminals (lead previously connected to the HI terminal now connected to the LO terminal and vice versa) and repeat the test listed in Table 4-2, ensuring that the listed outputs are now negative.

Table 4-2. Low Range DC Voltage Tests

RANGE	DIVIDER SETTING	8500A READING	
		LOW	HIGH
100 mV	.0010000	+ 9.995 (1–3)	+ 10.005 (–3)
100 mV	.0100000	+99.992 (–3)	+100.008 (–3)
1 V	.0100000	+ 0.09999	+ 0.10001
1 V	.1000000	+ 0.99997	+ 1.00003
10 V	.1000000	+ 0.9999	+ 1.0001
10 V	1.0000000	+ 9.9998	+ 10.0002

4-31. HIGH RANGE DC VOLTAGE TESTS

4-32. Perform the High Range Test as follows:

1. Connect the equipment as shown in Figure 4-2.

2. Verify that the test equipment is operating properly and any warmup period required has expired.

3. Verify that the 8500A warmup period of one hour is complete. Ensure that the VDC ⎓ function is selected with the VDC indicator illuminated and that the instrument is in manual ranging in the 100 volt range. The SAMPLE indicator should be flashing approximately eight times per second (32 samples per reading) and all other indicators should be extinguished.

4. Set the Reference Divider Standard Cell voltage controls to the standard cell certified value and both the input and output controls to 10 volts.

5. Set the DC Voltage Standard to approximately 10 volts, then adjust its output for a null reading on the null meter.

6. The 8500A reading displayed is between + 9.999 and + 10.001.
7. Set the Reference Divider input and output controls to 100 volts.
8. Set the DC Voltage Standard to approximately 100 volts, then adjust its output for a null reading on the null meter.
9. The 8500A reading displayed is between + 99.997 and + 100.003.
10. Increment the 8500A range manually to 1000 volts.
11. The 8500A reading displayed is between + 99.99 and + 100.01.
12. Set the Reference Divider input and output controls to 1000 volts.
13. Set the DC Voltage Standard to approximately 1000 volts, then adjust its output for a null reading on the null meter.
14. The 8500A reading displayed is between + 999.97 and + 1000.03.
15. Set the DC Voltage Standard to standby.
16. Reverse the leads at the DC Voltage Standard and standard cell terminals (lead previously HI to LO and vice versa).
17. Set the DC Voltage Standard to operate and repeat steps 4 through 17, ensuring that the listed outputs are now negative.

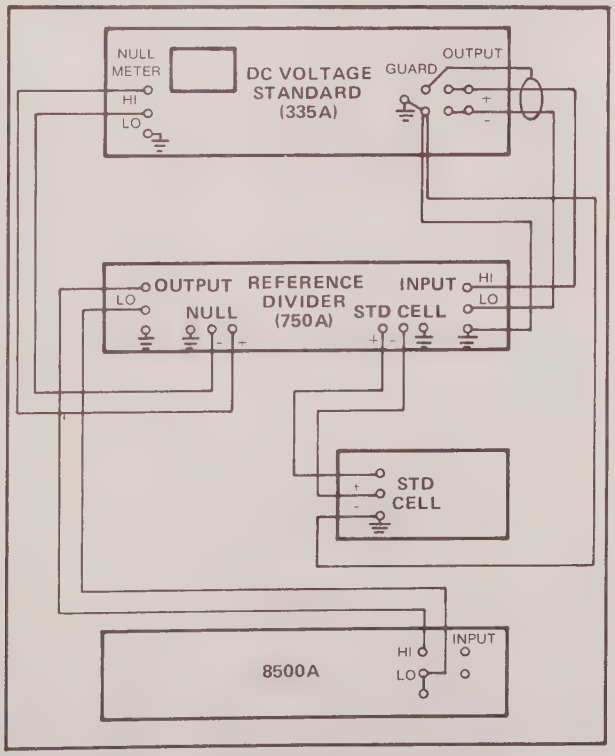


Figure 4-2. Connections For High Range DC Voltage Tests

4-33. AUTORANGING TEST

4-34. Test the autoranging capability of the 8500A with the following procedure:

1. Verify that the DC Volts and Autoranging modes are selected on the 8500A.
2. Connect the 8500A input directly to the DC Voltage Standard output.
3. Vary the output of the voltage source through its range, checking that the instrument autoranges approximately at the points indicated in Table 4-3.

Table 4-3. Autoranging

8500A CHANGES RANGE		NOMINAL READING
FROM	TO	
100 mV	1 V	312.5 mV
1 V	10 V	2.5 V
10 V	100 V	20 V
100 V	1000 V	160 V
1000 V	100 V	120 V
100 V	10 V	15
10 V	1 V	1.875
1 V	100 mV	0.234375

4-35. DC EXTERNAL REFERENCE

4-36. Test the DC four wire true ratio, using the following procedure:

1. Connect the test equipment to the 8500A as shown in Figure 4-3.
2. Select the VDC function and Autoranging on the 8500A.
3. Set the DC Voltage Standard controls for + 10.0000 volt output and the Voltage Divider controls to 1.000000.
4. Depress and hold the EXT REF switch. As long as the switch is held, the 8500A display reads the External Reference input of 10 volts (between 9.9998 and 10.0002).
5. Release the EXT REF switch. The 8500A computes the ratio ($^{V}IN/^{V}REF$) and displays a reading between 0.99996 and 1.00004.
6. Set the Voltage Divider controls to 0.1000000.
7. The 8500A displays a reading between 99.9995 (–3) and 100.005 (–3).
8. Depress the EXT REF switch to toggle the 8500A out of the External Reference mode.
9. Remove power from the test equipment and disconnect it from the 8500A.

CHECK ERRATA # 2

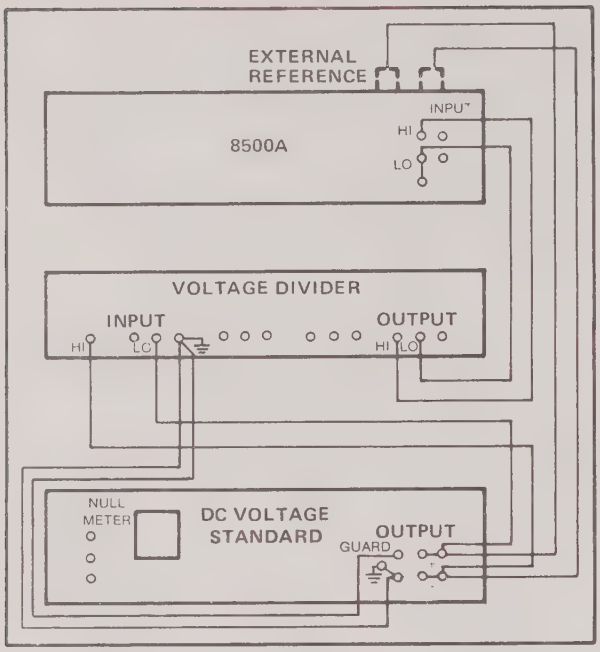


Figure 4-3. DC External Reference Test

4-37. CALIBRATION PROCEDURES

NOTE

The standards called out in the following procedure are required to meet the published specifications. If this accuracy is not required for a particular function (e.g., Resistance, DC Current, etc.), standards with a lower rated accuracy may be used. The accuracy of the 8500A function will then be based on the accuracy of the standard used, rather than the published specifications.

4-38. Introduction

4-39. The 8500A should be calibrated every 90 days or 1 year, as required to meet the applicable accuracy specifications. It should also be recalibrated any time that repairs are made to the instrument. When performing the calibration, the ambient temperature should be 23°C ± 2°C and the relative humidity should be less than 75%. Refer to Table 4-1 for the recommended test equipment. Check the instruction manuals for the various pieces of test equipment for the correct warmup periods. Power Supply adjustments are shown in Figure 4-4. Adjustments and test points on the remaining pcbs are accessible on the top edge of the board by popping open the hinged module top. Adjustments are labeled on the underside of the module top.

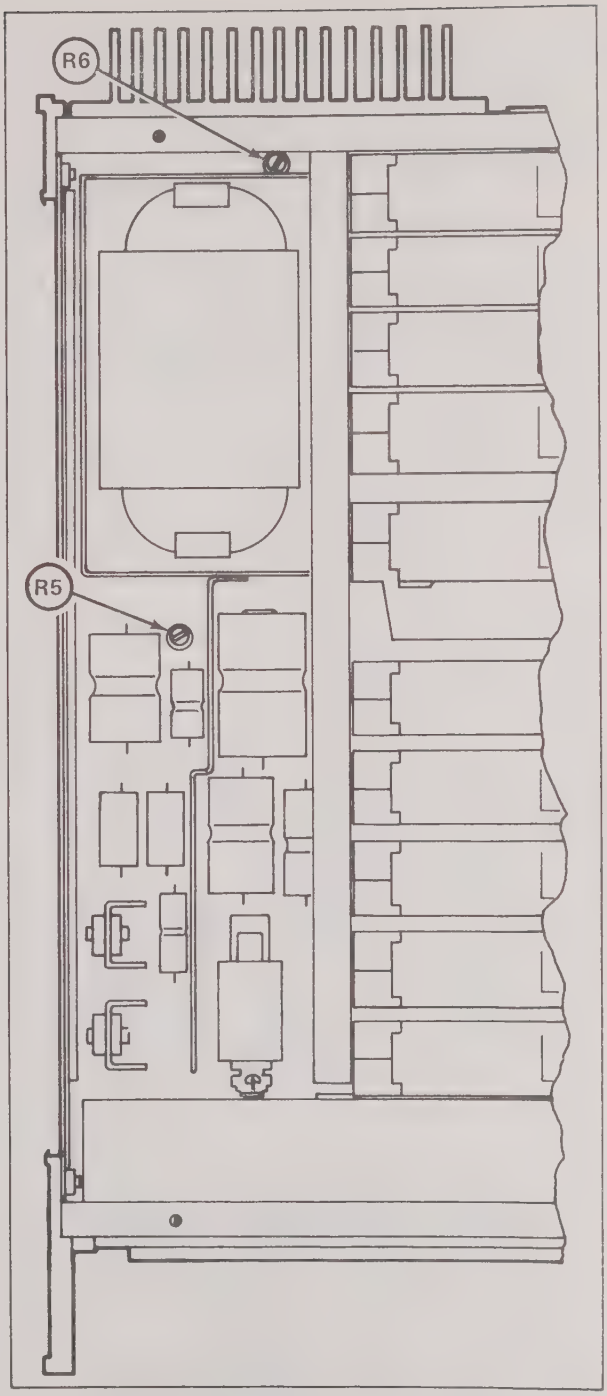


Figure 4-4. Power Supply Adjustments

4-40. Preliminary Operations

1. With the POWER switch OFF, replace the Isolator or Bus Interconnect, whichever is installed, with the Bus Interconnect and Monitor pcb assembly MIS-7013K. Remove the CAL Memory if installed.

CHECK ERRATA 3

CHANGE #1 26

After completing calibration, reinstall the CAL Memory and enter new calibration factors (should be zeros).

2. Set the POWER switch to ON and allow the instrument to warm up for at least one hour before continuing with the calibration.

4-41. Power Supply

4-42. Perform the Power Supply checks and adjustments as follows:

CAUTION!
Do not use the 8500A to check its own supplies.

1. Connect the test DMM HI input to Vcc on the Bus Interconnect and Monitor pcb and the LO input to Vss.
2. Adjust R6 for a reading between +5.00 and +5.10V dc to set the Logic Supply.
3. Transfer the HI DMM input lead to VA2.
4. Adjust R5 for a reading between +5.00 and +5.10V dc to set the Analog Supply.
5. Verify that the voltages in Table 4-4 are within the prescribed limits.
6. Prepare the test DMM to read AC volts and verify that the voltage between ~~RTS~~ LINE and Vss reads between 13 and 17V ac.
7. Turn the POWER switch to OFF and remove the Bus Interconnect and Monitor pcb and return the Isolator or Bus Interconnect to the instrument.
8. Reapply power to the 8500A.

Table 4-4. Power Supply Verifications

TEST POINTS		VOLTAGE RANGE (Vdc)		SUPPLY
HIGH	LOW	FROM	TO	
V_{DD}	V_{SS}	+ 11.4	+ 12.6	Logic
V_{GG}	V_{SS}	− 11.4	− 12.6	Logic
VA1	AR	+ 14.25	+ 15.75	Analog
VA2	AR	− 14.25	− 15.75	Analog
VA3	AR	+ 29.7	+ 31.7	Analog
VA4	AR	− 29.7	+ 31.7	Analog

4-43. DC Calibration Procedure

4-44. The offset adjustment, R14, in the Active Filter does not require adjustment unless Q27 or U5 have been replaced. There are no other adjustments in the Active Filter. Refer to troubleshooting, Figure 4-9, in this section for adjustment procedures for R14.

4-45. DC CONDITIONER ADJUSTMENTS

4-46. All adjustments and test points in the following procedures are on the DC Signal Conditioner. Perform the subtest, using the following procedure:

1. Select V DC, the 100 mV range, the slow filter (indicator on), the 2 readings per second sample rate, and the CAL switch ON (CAL indicator illuminated).
2. Short the 8500A input terminals.
3. Adjust R53 for a reading of 0 μV ±0 μV.
4. Remove the short from the input terminals and apply a 1 MΩ/0.22 μF parallel load.
5. Adjust R52 for a reading between −0.002 and +0.002V dc (0 ±2 μV).
6. Repeat steps 2 through 5 until both readings are present without an adjustment.

4-47. A/D CONVERTER CALIBRATION PROCEDURES

4-48. Use the following procedures to calibrate the A/D Converter. All test points and adjustments are on the A/D Converter.

4-49. This paragraph contains the adjustment procedure for R64. R64 requires adjustment only if R54 in the tens bit ladder has been replaced during repair. Unless R54 has been replaced, go on to the next paragraph.

1. Connect the test DMM HI to TP7, LO to TP6.
2. Adjust R1 for a test DMM reading of −7.000X V.
3. Remove the test DMM.
4. Using the test connections in Figure 4-1, apply 10.10000 volts dc to the 8500A input terminals.
5. Adjust R64 for an 8500A reading of +10.10000 ±5 cal digits.
6. Continue with the following adjustments.

4-50. A/D Zero Adjustment

1. Select the 10V range on the 8500A.
2. Short the 8500A input terminals.
3. Adjust R8 for a reading of 0.0000-0 ±1 cal digit.

4-51. A/D Calibrator Settings

4-52. Prepare the DC Voltage Standard for use during the A/D Calibration using the following procedure:

1. Connect the equipment, as shown with the solid lines in Figure 4-1. Do not connect the 8500A at this time.

2. Set the Voltage Divider controls at one-tenth the standard cell certified value (standard cell value x 0.1).

3. Adjust the DC Voltage Standard output for a null on the null meter.

4. Record the dial setting of the DC Voltage Standard as "Control Setting A." This setting will be used later in the procedure, in addition to the following paragraph.

5. Disconnect the leads at the Voltage Divider output terminals from the null meter and standard cell and connect the 8500A as shown with the broken lines in Figure 4-1.

4-53. A/D Ladder Adjustments

1. Select the 10V manual range on the 8500A.

2. Set the Voltage Divider controls for a ratio of 1.0100000.

3. Adjust R1 for a reading between +10.0999-9 and +10.1000-1 (+10.1000-0 ±1 cal digit).

4. Reverse the polarity of the dc voltage at the DC Voltage Standard for a negative input to the 8500A.

5. Adjust R2 for a reading between −10.0999-9 and −10.1000-1 (−10.1000-0 ±1 cal digit).

6. Return the polarity of the dc voltage to a positive output from the DC Voltage Standard input at the 8500A.

7. Set the Voltage Divider controls for a ratio of .0500000.

8. Adjust R7 for a reading between +0.4999-9 and +0.5000-1 (+0.5000-0 ±1 cal digit).

9. Repeat steps 2 through 8 until all readings are within tolerance without making an adjustment.

10. Set the Voltage Divider controls for ratio of .5100000.

11. Adjust R6 for a reading between +5.0999-9 and +5.1000-1 (+5.1000-0 ±1 cal digit).

12. Set the Voltage Divider controls for a ratio of .2600000.

13. Adjust R5 for a reading between +2.5999-9 and + 2.6000-1 (+2.6000-0 ±1 cal digit).

14. Set the Voltage Divider controls for a ratio of .1400000.

15. Adjust R4 for a reading between +1.3999-9 and +1.4000-1 (+1.4000-0 ±1 cal digit).

16. Set the Voltage Divider controls for a ratio of .0750000.

17. Adjust R3 for a reading between +0.7499-9 and 0.7500-1 (0.7500-0 ±1 cal digit).

18. Repeat steps 2 through 17 until all steps are within the stated tolerance.

4-54. Linearity Verification

1. Verify that the 8500A sample rate is set at two readings/second and the 10V manual range is selected.

2. Set the Voltage Divider controls for a ratio of .2000000.

3. Set the DC Voltage Standard for an output of approximately 100 volts and adjust its output for a reading between +19.9999-9 and +20.0000-1 on the 8500A.

4. Set the Voltage Divider controls for a ratio of .0000000 and verify that the reading is between −0.0000-1 and +0.0000-1 (0 ±1 cal digit).

5. Reverse the polarity of the dc voltage at the DC Voltage Standard for negative input to the 8500A.

6. Verify that the 8500A reads between −0.0000-1 and +0.0000-1 (0 ±1 cal digit).

7. Return the polarity of the dc voltage output from the DC Voltage Standard to a positive input at the 8500A.

8. Set the Voltage Divider controls to the settings listed in Table 4-5, verifying that the readings are within the tolerances listed in the table.

9. Reverse the polarity of the DC Voltage Standard output and repeat the steps in Table 4-5, checking that the reading is negative and within the listed tolerance.

10. Set the DC Voltage Standard for the "Control Setting A" recorded earlier.

11. Set the Voltage Divider controls for a ratio of 1.0000000.

12. Verify that the 8500A reads between +9.9999-9 and +10.0000-1 (+10.0000-0 ±1 cal digit).

Table 4-5. Linearity Checks

DIVIDER SETTING	READINGS		
	MINIMUM	NOMINAL	MAXIMUM
.0100000	0.9999-5	1.0000-0	1.0000-5
.0200000	1.9999-5	2.0000-0	2.0000-5
.0300000	2.9999-5	3.0000-0	3.0000-5
.0400000	3.9999-5	4.0000-0	4.0000-5
.0500000	4.9999-5	5.0000-0	5.0000-5
.0600000	5.9999-5	6.0000-0	6.0000-5
.0700000	6.9999-5	7.0000-0	7.0000-5
.0800000	7.9999-5	8.0000-0	8.0000-5
.0900000	8.9999-5	9.0000-0	9.0000-5
.1000000	9.9999-5	10.0000-0	10.0000-5
.1100000	10.9999-4	11.0000-0	11.0000-6
.1200000	11.9999-4	12.0000-0	12.0000-6
.1300000	12.9999-4	13.0000-0	13.0000-6
.1400000	13.9999-3	14.0000-0	14.0000-7
.1500000	14.9999-3	15.0000-0	15.0000-7
.1600000	15.9999-3	16.0000-0	16.0000-7
.1700000	16.9999-2	17.0000-0	17.0000-8
.1800000	17.9999-2	18.0000-0	18.0000-8
.1900000	18.9999-2	19.0000-0	19.0000-8
.2000000	19.9999-2	20.0000-0	20.0000-8

4-54. RANGE ADJUSTMENTS

4-56. All adjustments and test points in the following procedure are on the DC signal conditioner. Perform the subtests using the following procedures.

4-57. Perform the 100 mV range adjust as follows:

1. Ensure that the DC Voltage Standard is set for "Control Setting A."
2. Set the Voltage Divider controls for a ratio of .0000000.
3. Select the 100 mV range on the 8500A.
4. If required, readjust R53, for a reading of 0 ±0 μV.
5. Set the Voltage Divider controls for a ratio of .0300000.
6. Adjust R49 for a reading between +299.999 and +300.001 (+300.000 ±1 digit).

4-58. Perform the 1V range adjust as follows:

1. Select the 1V range on the 8500A.
2. Set the Voltage Divider controls for a ratio of .2500000.
3. Adjust R48 for a reading between +2.49999-9 and +2.50000-1 (+2.50000-0 ±1 cal digit).

4-59. Perform the 100V range adjust as follows:

1. Connect the equipment as shown in Figure 4-2.
2. Select the 100V range on the 8500A.
3. Set the Reference Divider Standard Cell voltage controls to the standard cell certified value and both the input and output controls to 100 volts.
4. Set the DC Voltage Standard to approximately 100 volts, then adjust its output for a null on the null meter.
5. Adjust R47 for a reading between +99.999-9 and 100.000-1 (+100.000-0 ±1 cal digit).

4-60. Perform the 1000V range adjust as follows:

1. Select the 1000V range on the 8500A and take the instrument out of the Cal mode by moving the CAL switch to OFF (CAL indicator extinguishes).
2. Verify that the 100 volt setting on the Reference Divider is still nulled.
3. The 8500A should read between +99.98 and +100.02 (+100.00 ±2 digits).
4. Set the Reference Divider input and output controls to 500 volts.
5. Set the DC Voltage Standard to approximately 500 volts, then adjust its output for a null on the null meter.
6. The 8500A should read between +499.98 and +500.02 (+500.00 ±2 digits).
7. Set the Reference Divider input and output controls to 1000 volts.
8. Set the DC Voltage Standard to approximately 1000 volts, then adjust its output for a null on the null meter.
9. The 8500A should read between +999.98 and +1000.02 (1000.00 ±2 digits).

4-61. TROUBLESHOOTING

⊗ CAUTION

Static discharge can damage components contained in the 8500A. To prevent this possibility, use the following precautions when troubleshooting and/or repairing the unit.

1. Never remove, install, or otherwise connect or disconnect modules and/or components without first turning the 8500A Power switch to OFF.
2. Perform all repairs at a static-free work station.
3. Do not handle IC's or pcb's by their connectors.
4. Use static ground straps to discharge repair personnel.

CHECK ERRATA

5. Use conductive foam to store replacement or removed IC's.

6. Remove all plastic, vinyl, and styrafoam products from the work area.

7. Use a grounded soldering iron.

4-62. A procedure for isolating faulty modules is contained in Table 4-6. It is important that the theory of operation given in Section 3 be read before attempting to troubleshoot the 8500A. The module isolation procedure involves making observations of the 8500A behavior, then removing or replacing modules to establish cause-effect relationships. DO NOT remove or replace modules with the power on. Follow the procedure step by step all the way through to assure that the fault is isolated to the correct module. Faults in some modules may cause apparent faults in other modules.

CAUTION

If the Isolator and the Bit Serial Asynchronous interface are installed, replacement of the Isolator by the Bus Interconnect Monitor pcb may allow a hazardous common mode voltage to appear on the output connector of the interface.

4-63. Figures 4-5 through 4-11 contain symptom analysis troubleshooting information for each of the modules and pcb's contained in the mainframe 8500A. The possible failures are listed in order of probability. Troubleshooting information for optional modules is contained in Section 6.

4-64. Troubleshooting Notes

4-65. By selecting the CAL mode, Error Codes are disabled. Any function may be selected and, if the module is not installed, random readings will be displayed.

4-66. In using the Bus Interconnect Monitor pcb, note that RT1 physically does not extend to the Isolator-Interconnect slot. RT1 is accessible with the Monitor pcb installed in any of the first four slots (J11A, B, C, or D). The outputs of the optional Ohms Converter and Current Shunts modules are on RT1.

4-67. DO NOT apply an input directly to the A/D Converter module. Damage to the A/D Converter may result. The DC Signal Conditioner may be bypassed by applying a signal directly to the Active Filter module, as outlined in the module isolation procedure.

4-68. Module Disassembly

4-69. All modules in the 8500A are mounted in shielded cases which may be disassembled, using the following procedure. Avoid using excessive force to prevent breaking the plastic.

1. Pop open the lid by using the indentations at either end and lifting up. Hinge the lid back.

2. Orient the module with one of the guides up.

3. Press down on the end of the case half above the words "OPEN" while pulling up lightly on the lip of the module guide and just separate that end.

4. Repeat step 3 for the other end.

5. Open the top of the module and the bottom catch will automatically come apart.

6. Press down on the top of the pcb while pulling out to free the pcb from the case half.

4-70. Use the following procedure for module reassembly.

1. Insert the pcb in the case half bottom first and lightly press down on the top to snap it in place.

2. Ensure that the spring shield connection is not caught behind the pcb.

3. Align the bottom center catch of the case halves, making sure the shields at either end fit together properly.

4. Close the two halves together, snapping the module guides closed.

5. Using a small screwdriver or similar tool, lift the spring shield connection so that it rests on the shield opposite.

4-71. Troubleshooting Aids

4-72. The Static Controller (MIS-7190K) and the Test Module (MIS-7191K) are valuable troubleshooting aids for the 8500A. Further information concerning these troubleshooting aids is available from any Sales Office. Troubleshooting procedures using the Static Controller and the Test Module will be included with the modules.

Table 4-6. Faulty Module Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1.	Turn the power ON. The following should be displayed. HI 1.0.Y (Y=Program number) then C XXXXX (X = installed option number) then 0.00 ±.05 (DC Volts, 1000V range, Fast sample rate)		
2.	Is the display blank?	6	3
3.	Is the initial display other than HI 1.0.0?	42	4
4.	Is the reading other than 0.00 ±.05	59	5
5.	Are the first three displays normal?	78	2
	DISPLAY BLANK AT POWER ON		
6.	Remove bus interconnect (or Isolator if installed).		
7.	Turn power ON. Is HI 1.0.0 displayed?	8	11
8.	Was the isolator installed?	9	11
9.	Install interconnect-monitor in the Isolator slot. Is HI 1.0.0 displayed?	10	13
10.	Bad Isolator. Go to Section 6 under Isolator.		
11.	Is the power indicator on?	17	12
12.	Check the fuse. Is it bad (replace)?	1	17
13.	Remove Cal Memory and remote interfaces if installed. Is HI 1.0.0 displayed?	14	17
14.	Replace Cal Memory. Is HI 1.0.0 displayed?	16	15
15.	Bad Cal Memory. Go to Section 6 under Calibration Memory.		
16.	Bad Remote Interface. Go to Section 6 under the appropriate interface.		
17.	Install the interconnect-monitor PCB in the Isolator slot.		
18.	Check power supply voltages as follows. Test DMM Common to VSS. V_{DD} = +11.4 to +12.6 V_{CC} = +5.15 to 5.25 V_{GG} = −11.4 to −12.6 LINE = 13V ac to 17V ac		
19.	Are the power supplies within tolerance?	26	20
20.	Remove all modules except the Front Panel.		
21.	Recheck power supplies. Within tolerance?	22	23
22.	Replace modules one at a time (start with Controller), rechecking supplies after replacing each module. The last one put in when the supplies go bad is the rotten egg. Go to the appropriate figure for that module.		
23.	Remove the front panel. Recheck supplies. Within tolerance?	25	24
24.	Problem on power supply, motherboard, or power supply interconnect.		
25.	Bad Front Panel. Go to Figure 4-7.		

Table 4-6. Faulty Module Isolation (Continued)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
26.	Remove Cal Memory and the remote interface if installed.		
27.	Check IC 6, 5, 1, 0 on interbus. All moving?	28	30
28.	Check ACK line. Moving?	29	30
29.	Check ID0 –7. All moving?	32	30
30.	Check Controller clock, TP2, TP3 (TP1 = gnd). Is 12V, 1.7 MHz signal present?	33	31
31.	Bad Controller. Go to Figure 4-6.		
32.	Bad Front Panel. Go to Figure 4-7.		
33.	Remove analog modules, leaving only Controller, Front Panel, and Interconnect. Is the display normal?	34	35
34.	Faulty Analog Module. Replace one at a time — last one in is the rotten egg. Go to the appropriate figure for that module		
35.	Remove Front Panel, replace DC Signal Conditioner, Filter, A/D Converter.		
36.	Check IC lines, ACK line, ID lines. All moving?	38	37
37.	Bad Controller. Go to Figure 4-6.		
38.	Bad Front Panel. Go to Figure 4-7.		
	INITIAL DISPLAY OTHER THAN HI 1.0.0		
39.	Remove Interconnect PCB (or Isolator if installed).		
40.	Apply power. Is the display as follows? HI 1.0.0 C XXXXX Error 9	41	44
41.	Was the Isolator installed?	42	47
42.	Install Interconnect-monitor PCB in Isolator slot. Is display normal?	43	48
43.	Bad Isolator. Go to Section 6.		
44.	Are Cal Memory or remote interface installed?	45	47
45.	Remove Cal Memory and remote. Display normal?	46	47
46.	Replace one at a time. Last one in is the rotten egg. Go to appropriate figure.		
47	Install Interconnect-Monitor PCB.		
48.	Check for shorts between the IC and the ID lines. Shorts?	49	51
49.	Remove all modules except Front Panel. Removed short?	50	57
50.	Reinstall modules one at a time (start with Controller), checking for shorts between modules. Last one in is the rotten egg. Go to the figure for the appropriate module.		

Table 4-6. Faulty Module Isolation (Continued)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
51.	Are any of the IC, ID, or ACK lines always high or always low?	53	52
52.	Remove all modules except Front Panel and Controller. IC and ID moving?	56	53
53.	Remove Front Panel. Reinstall dc analog modules if removed.		
54.	Are the IC, ID, and ACK lines moving?	57	55
55.	Bad Controller. Go to Figure 4-6.		
56.	Is the display normal?	58	57
57.	Front Panel bad. Go to Figure 4-7.		
58.	Faulty Analog module. Replace one at a time until symptoms recur. Last one in is faulty. Go to the figure for the appropriate module		
	READING NOT ZERO AT TURN ON		
59.	Remove all optional modules (except Isolator if installed), leaving Controller, (Isolator), DC Signal Conditioner, Filter, A/D, Front Panel.		
60.	Apply power. Is the reading zero?	61	62
61.	Replace modules one at a time until reading is not zero. Last one in is the rotten egg. Go to Section 6.		
62.	Is the Isolator installed?	63	65
63.	Replace Isolator with Interconnect-Monitor PCB. Is the reading zero?	64	65
64.	Bad Isolator. Go to Section 6.		
65.	Install Interconnect Monitor if not already installed. Check supply voltages as follows. Test DMM LO on AR (analog return). VA1 = +14.25 to +15.75 V VA4 = −29 to −32 V VA2 = −14.25 to −15.75V V_{CC} = −15V } Difference must equal VA3 = +29 to +32V V_{SS} = −20V } 4.9 to 5.2V		
66.	Supply voltages in tolerance?	70	67
67.	Remove all modules except Front Panel. Supplies in tolerance?	69	68
68.	Repair power supply. Go to Figure 4-5.		
69.	Replace modules one at a time, checking supplies between modules. Last one in is faulty. Go to the appropriate figure.		
70.	Remove Filter module. CAL switch on. Select DC Volts, 1000V range.		
71.	Is the reading zero?	72	77
72.	Replace Filter module; remove DC Signal Conditioner.		
73.	Place a jumber (short) between RT2 and RT6.		
74.	Is the reading zero (disregarding CAL digit)?	75	76

Table 4-6. Faulty Module Isolation (Continued)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
75.	DC Signal Conditioner bad. Go to Figure 4-8.		
76.	Filter module bad. Go to Figure 4-9.		
77.	A/D converter bad. Go to Figure 4-10.		
78.	Do the Performance Tests earlier in this section.		
79.	Is the unit within the tolerances given?		80
80.	Is the Cal Memory installed?	81	83
81.	Remove the Cal Memory. Is the unit now within tolerance?	82	83
82.	Faulty Cal Memory. Go to Section 6.		
83.	Is the Isolator installed?	84	87
84.	Replace Isolator with Interconnect-monitor PCB.		
85.	Is unit within tolerance?	86	87
86.	Bad Isolator. Go to Section 6.		
87.	Is the failure in DC Volts Performance Test?	89	88
88.	Go to Section 6 for the appropriate faulty function.		
89.	Remove all optional modules, leaving Front Panel, Controller, DC Signal Conditioner, Active Filter, and A/D Converter.		
90.	Do the DC Volts Performance Test. Is the unit within tolerance?	91	92
91.	Reinstall options one at a time, rechecking DC Volts tolerance. Last module installed when unit becomes out of tolerance is faulty. Go to Section 6.		
92.	Check supply voltages according to the following chart. VA1 = +14.25 to +15.75V VA4 = −29 to −32V VA2 = −14.25 to −15.75V V_{CC} = −15V) Difference = 4.9 to 5.2V VA3 = +29 to +32V V_{SS} = −20V)		
93.	Are the supplies within tolerance?	97	94
94.	Remove all modules except Controller and Front Panel. Are the voltages correct?	95	96
95.	Replace modules one at a time until the voltages go bad. Last one in is the rotten egg. Go to the appropriate figure.		
96.	Repair power supply. Go to Figure 4-5.		

Table 4-6. Faulty Module Isolation (Concluded)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
97.	Connect the test DMM LO to RT2 and HI to RT6. Apply known voltages to the 8500A input to test the DC Signal Conditioner. The following voltages are suggested inputs:		
	8500A RANGE / GAIN DC SIG COND / INPUT / TEST DMM READING		
	100mV / X64 / 2mV / 128.0mV		
	100mV / X64 / 200 mV / 12.80V		
	1V / X8 / 125mV / 1.0V		
	1V / X8 / 2V / 16.0V		
	10V / X1 / 1V / 1.0V		
	10V / X1 / 19V / 19.0V		
	100V / ÷8 / 1V / 125.0mV		
	100V / ÷8 / 140V / 17.50V		
	1000V / ÷64 / 64V / 1.0V		
	1000V / ÷64 / 960V / 15.0V		
98.	Are the readings correct (noise or drift in the DC Signal Conditioner will show up on the Test DMM readings)?	100	99
99.	DC Signal Conditioner faulty. Go to Figure 4-8.		
100.	Connect Test DMM HI to RT5. Repeat table in step 97. The test DMM readings should be the same.		
101.	Are the Test DMM readings the same?	103	102
102.	Faulty Active Filter module. Go to Figure 4-9.		
103.	Faulty A/D Converter. Go to Figure 4-10.		

SYMPTOM	POSSIBLE FAILURE
GUARDED SUPPLY	
VA1 – BAD	U3, BR2, or Transformer
(+15V). Noisy	C3, BR2
VA2 – BAD	U4, BR2, or Transformer
(–15V) Noisy	C4, BR2
VA3 – BAD	U2, CR4, BR1, Transformer
(+30V) Noisy	C2, BR1
VA4 – BAD	U1, CR3, BR1, Transformer
(–30V) Noisy	C1, BR2
V_{CC} (Guarded)	U5, R5, R3, C5, CR1, CR2, Transformer

VA1 and VA2 are used as a reference for VA3 and VA4. VA3 and VA4 could load down VA1 and VA2. Check by lifting the reference diodes CR3 and CR4.

UNGUARDED SUPPLY	
V_{DD} (+12V)	U6, C6, C9, C12, BR3, Transformer
V_{GG} (–12V)	U7, C13, C10, C7, BR3, Transformer
V_{CC} (+5V)	U8, R6, R4, C8, C13, C11, BR4, Transformer

The drawing below identifies the pins at the power supply edge connector. Input voltages to the regulators should be approximately 5V higher than the normal output voltages. If the output is higher or lower than specified and noise is not the problem, the regulator is bad.

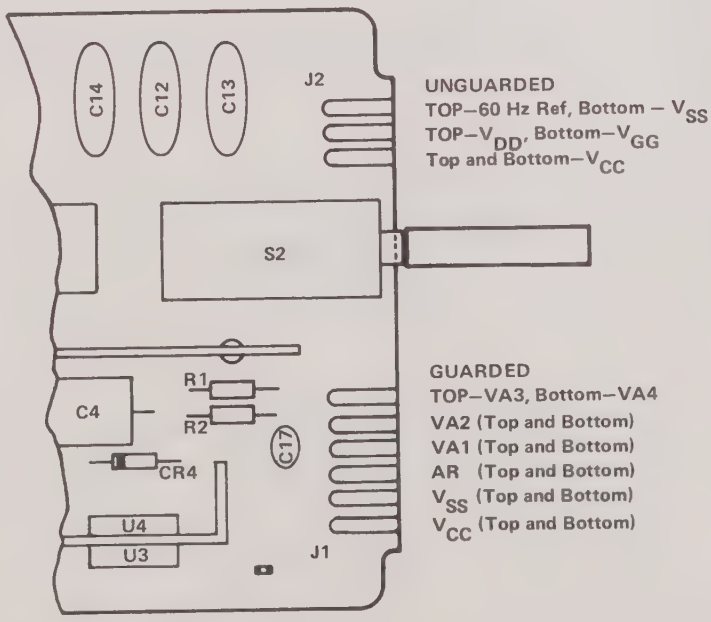


Figure 4-5. Power Supply Troubleshooting

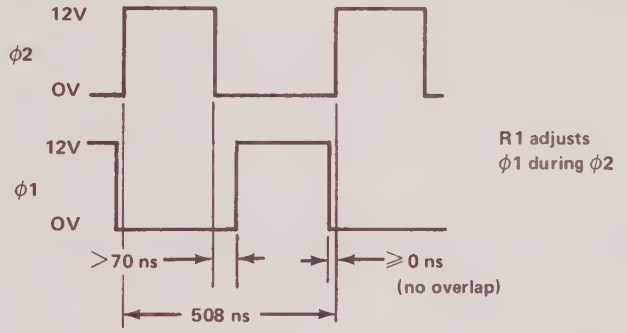
CHANGE #29

NOTE

Due to the speed and complexity of the controller, it is recommended that, when a problem is isolated to the controller, the unit be sent to the nearest Service Center for repair. The following information will assist in troubleshooting simpler problems. Many problems require the use of a Trendar or similar tester.

SYMPTOM	POSSIBLE FAILURE
Troubleshoot the Controller with only the Controller, Front Panel, and Power Supply installed.	
Blank Display (most common symptom of controller failure)	Proceed with checks listed below

1. Check $\phi 1$ and $\phi 2$ clock at TP2, TP3



$\phi 1$ bad, $\phi 2$ ok	U3, U9, U10
$\phi 1$ ok, $\phi 2$ bad	U9, U10
$\phi 1$, $\phi 2$ bad	U3, U9, Y1
$\phi 1$ won't adjust	R1, U3, U9, capacitors

2. Check RST 9reset) line (at U10-12, U35-13)

   High? Check for 400 μsec delay on +5V at U36-13

   Stuck Low? U35, U34, U36, U38

3. Check RDT (ready) line (at U10-23, U1-9)

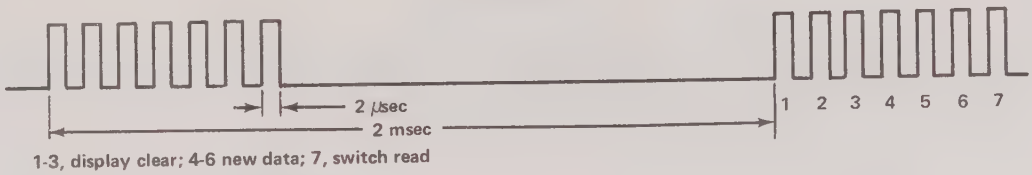
   Pulsing – OK

   Always low . . . . . clock pulse at U1-12 U1, U16, U15, U8– check inputs to U8, U18

   Always high . . . . . ACK interrupt or mark interrupt not functioning properly

Figure 4-6. Controller Troubleshooting

SYMPTOM	POSSIBLE FAILURE
4. Check Bus ACK Signal.	



1-3, display clear; 4-6 new data; 7, switch read

No pulses on ACK line	Mark interrupt circuit (U14-12, U37-3) Phase lock loop (pulses every 2 msec) IC lines output enable (U17-10) IC lines output gates (U29, U37)
ACK always high	U38, CR1, C27
5. Check IB OUT (U17-9) — is data going out?	
6. Check A15, WAIT, WR, and DBIN lines	U10, ROM enable, ROM decoders, ROM
7. Check address and data lines at U10 for being held high or low all the time.	
8. If MARKS, INT, INTE OK, INT VECTOR (U28, U19, U37) may be bad giving wrong vector information.	
OTHER PROBLEMS	
Won't read switches	IC6 bad (no ACK) or bad data in
Displays all modules present (CXXXXX)	ACK INT CKT, ACK held high
Wrong display	Data bad, IC line always high
Won't respond to external interrupts	U17 (INT), U37, U32 (INA) U28, U19, U23 (INT Vector wrong)

Figure 4-6. Controller Troubleshooting (Concluded)

SYMPTOM	POSSIBLE FAILURE
No ACK Pulse	U28, U19 (Address Decoders) U23 (Indirect F/F) U19, U11, Q10 (ACK Circuit)
No Display (ACK Pulse Present)	U18 (Kill Circuit)
No Response to Switch Pushes (Display Good)	Switch Associated With Function U32, CR1 — CR4 Open
Segment Bad In All LEDs	Check Path from Latch to Transistor Drivers to LED Cathodes
One LED Doesn't Light	Check Path From Latch To Inverter to Transistor Drivers to LED Anode
Segment or Decimal Missing On Only One LED	Bad LED
Display Gives Wrong Numbers, One LED Brighter	U11 (Reset to Indirect Address F/F, U23) Address Decoder. (Problem is Indicative of Front Panel Responding to an Invalid Address.)

Figure 4-7. Front Panel Troubleshooting

SYMPTOM	POSSIBLE FAILURE
DC Inoperative All Ranges	Digital Control Logic Q8, Q6, Q7, Open K1, Q1, Q2 Open; Q18, Q19, U3 Bad
Display Blanks	U1 or U2
Locks in Overrange	U3
Reading Drifts	U4; Q14, Q15, Q16 Leaky
Won't Zero	U5 or U6
100 mV Range Bad	Q31, Q32, Q14
1V and 100V Range Bad	Q33, Q34, Q15
100V and 1000V Range Bad	K2, Q3, Q4
Random Readings	K1 Open, K2 Shorted
Nonlinear Readings	Q16, Q15, Q14 Leaky

ADDRESS AND DATA FIELD

ADDRESS	IB DATA DURING ADDRESS				
IC4, IC3, IC0 = 1	ID3	ID2	ID1	ID0	
	0	1	1	0	100 mV Range G = 64
	1	0	1	0	1V Range G = 8
	1	1	0	1	10V Range G = 1
	1	0	0	0	100V Range G = ÷8 (÷64 x 8)
	1	1	0	0	100V Range G = ÷64

ID3 - ID4 = Control Amplifier Gain

0 1 = x 64
1 0 = x 8
1 1 = z 1

RT1 inputs controlled as follows for OHMS & ADC

ADDRESS	DATA				
	ID3	ID2	ID1	ID0	
IC4, IC3, IC0 = 1	0	1	0	1	G = x 64
	1	0	0	1	G = x 8
	1	1	0	1	G = x 1

NOTE

If R54–R57, Q18, Q19 or Q22 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

Figure 4-8. DC Signal Conditioner Troubleshooting

SYMPTOM	POSSIBLE FAILURE
High Zero Offset	Q32, Q25, Q19, Q20 Shorted
DC Inoperative	Q18 Open – Q21, Q22, Q23, Q24 Open Q27, U5 Digital Logic
Overrange	U5 – Q19, Q20 Shorted
Noisy	
All Ranges	
Either Filter	Q25, Q32 Leaky – Q31, U5 Bad
Slow Filter (ON)	Q21, Q22 Leaky – U4 Bad
Fast Filter (OFF)	Q23, Q24 Leaky – U3 Bad
Nonlinear Readings	U5
Display Blanks	U1 Or U2

ADDRESS AND DATA FIELD

ADDRESS	DATA
IC4, IC3, & IC1 = 1	ID0 = 1 Filter By Pass (Remote Only) ID1 = 1 Z Filter (F.P. Light On) ID2 = 1 Y Filter (F.P. Light Off) ID3 = 1 Filter - Always on except In Ext. Ref. ID4 = 1 Ext. Ref. Lo ID5 = 1 Ext. Ref. Hi

Adjustment of R14

1. Short the 8500A input terminals.
2. Short RT6 to RT2 on the Bus Interconnect Monitor.
3. Adjust R14 for a reading of $\pm$.000000 $\pm$2 digits. (This requires that the A/D Converter is working accurately.)

Selection of R15 or R16.

If Q27 or U5 have been replaced, R15 and R16 will require reselection if adjustment of R14 does not zero the reading.

1. Only one of R15 and R16 will be installed. Replace whichever is installed with a short.
2. Connect the R15 short to the R16 short.
3. Short RT6 to RT2 on the Bus Interconnect Monitor.
4. Connect the test DMM HI to TP3 and LO to TP1 on the Active Filter module.
5. Select a resistor from the table below according to the measured offset. If the polarity is positive, install the resistor as R16; if negative as R15. (Maximum allowable offset in this step is 5200 μV.)

OFFSET (μV)	RESISTOR	JOHN FLUKE PART NO.
0-400	None	
401-1200	31.6K	261610
1201-2000	63.4K	235382
2001-2800	97.6K	241380
2801-3600	133.0K	289074
3601-4400	165.0K	376186
4401-5200	205.0K	375931

6. After installing the resistor, adjust R14.

Figure 4-9. Active Filter Troubleshooting

DIGITAL BOARD

SYMPTOM	POSSIBLE FAILURE
Display Blanks	U33, U34, U35 (Affecting ID Lines)
Improper Readings, Inoperative A/D, Nonlinear Readings	Check Transistor Array Outputs to J1 and J2 – The Rise and Fall Times of These Switching Pulses Must be <2 μsec.
Flickering Display	Autozero Control – U25, U34
Direct Address	
IC 4, 3, & 2 High	ID0 = 1 = Reset Counter ID1 = 1 = Auto Zero ID2 = 0 = Buffer Input ID2 = 1 = Remainder Input ID3 = 1 = Channel X (Auto Zero and Remainders 1 and 3) ID3 = 0 = Channel Y (Remainders 2 and 4)
Indirect Address	
IC 2 & 1 High (and Ring Counter Not in C0 Time period, C0 = 0)	This Indirect Address allows the ID7 Enable to bring back Polarity Bits to the Controller Module

ANALOG BOARD

First Check TP5 – Should be switching between + and –7V. Typical failures in this circuit result in a portion of the switching slope having a slew rate less than 1V/μsec. A glitch at the zero point is normal.

SYMPTOM	POSSIBLE FAILURE
Noisy Readings	U1, U2, U3
Nonlinear Ladder	U4, Q9, Q10 (Q27)
Ladder Out Of Tolerance	FETS Q11 – Q15 or Q17 – Q21
All Digits Wrong	U7, Q31, Q32
Reading Locked (Doesn't Respond To Input Change) Or Always Overrange	U4, Q9, U1, U2, U3, Q2, Q3
Bad Remainders (Lesser Digits)	Q22, U4, U6
No Polarity Bit Returned	Q29, Q28
Shifty Readings (Most Or All Digits)	Autozero Settling Time Problems U8, Q30 – Q8, Q7

NOTE

If U1, R9, R14-R16, R34, R35, R50-55, R67, Q1-Q3, Q11-Q16, Q25, or Q26 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

Figure 4-10. R² A/D Converter Troubleshooting

Section 5
List of Replaceable Parts

TABLE OF CONTENTS

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A3	Bus Interconnect PCB Assembly	459636	5-11
A4	Power Supply Assembly	448860	5-13
A5	Power Supply Interconnect	410760	5-15
A6	Controller PCB Assembly	384107	5-16
A7	Front Panel-Display Assembly		5-20
A8	D.C. Signal Conditioner Assembly (MIS-4100)	383901	5-24
A9	Active Filter Assembly	383745	5-28
A10	Fast R^2 A/D Converter Assembly		5-31

CHECK ERRATA

CHANGE #27

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the mainframe instrument. A parts breakdown for each of the optional modules is contained in the subsection of Section 6 pertaining to the module. Components are listed alpha-numerically by assembly. Electrical components are listed by reference designation and mechanical components are listed by item number. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation or Item Number.
2. Description of each part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufacturers. (See Appendix A for Code-to-Name list.)
5. Manufacturer's Part Number or Type.
6. Total Quantity per assembly or component.
7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.
8. Use Code is provided to identify certain parts that have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity, paragraph 5-7.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity.
2. FLUKE Stock Number.
3. Description.
4. Reference Designation or Item Number.
5. Printed Circuit Board Part Number.
6. Instrument Model and Serial Number.

5-7. USE CODE EFFECTIVITY LIST

USE CODE	SERIAL NUMBER EFFECTIVITY

⊗ CAUTION

Indicated devices are subject to damage by static discharge.

CHECK ERRATA

CHANGE #3, 4, 2)

A1 FINAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	**FINAL ASSEMBLY 15 INCH PACKAGE MODEL 8500A Figure: 5-1**	8500A	89536	8500A			
A2	Mother Board PCB Assembly tested (8500A-4001T) Figure: 5-2	459628	89536	459628	1		
A3	Bus Interconnect PCB Assembly (MIS-4081) Figure: 5-3	459636	89536	459636	1		
A4	Power Supply PCB Assembly tested (8500A-4031T) Figure: 5-4	448860	89536	448860	1		
A5	Power Supply Interconnect PCB Assembly (8500A-4032) See Figure 5-1	401760	89536	401760	1		
A6	⊗ Controller PCB Assembly tested (MIS-4185T) Figure: 5-5	384107	89536	384107	1		
A7	⊗ Front Panel Display PCB Assembly tested (8500A-4021T) Figure: 5-6	384032	89536	384032	1		
A8	⊗ DC Signal Conditioner PCB Assembly (MIS-4100T) Figure: 5-7	383901	89536	383901	1		
A9	⊗ Active Filter PCB Assembly (MIS-4130T) Figure: 5-8	383745	89536	383745	1		
A10	⊗ Fast R^2 A/D Converter PCB Assembly (MIS-4140T) Figure: 5-9 & 5-10	383984	89536	383984	1		
1	Bail, full width	231407	89536	231407	1		
2	Bezel, I/O	416206	89536	416206	1		
3	Button, pwr switch	401646	89536	401646	1		
4	Chassis Assy	383414	89536	383414	1		
~~5~~	~~Chassis Insulator~~	~~433938~~	~~89536~~	~~433938~~	~~1~~		
6	Channel, rubber	103622	83478	896	5		
7	Contact strip	370619	30817	97-500-A	.75 in.		
8	Corner, finished	349993	89536	349993	2		
9	Corner, handle	350009	89536	350009	2		
10	Cover, bottom	383265	89536	383265	1		
11	Cover, plate, rear input	420679	89536	429679	1		

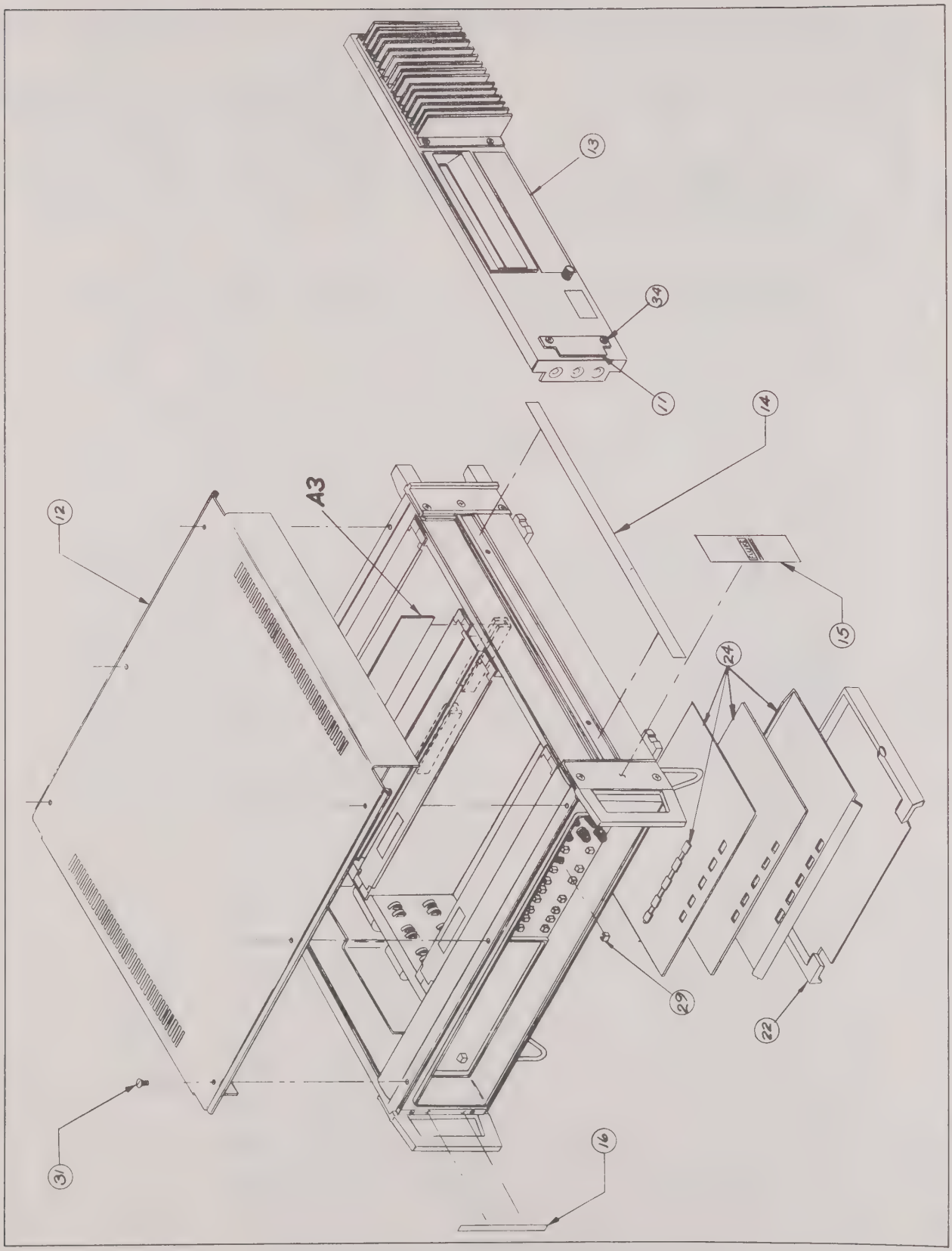


Figure 5-1. A1 Final Assembly (8500A) (Sheet 1 of 2)

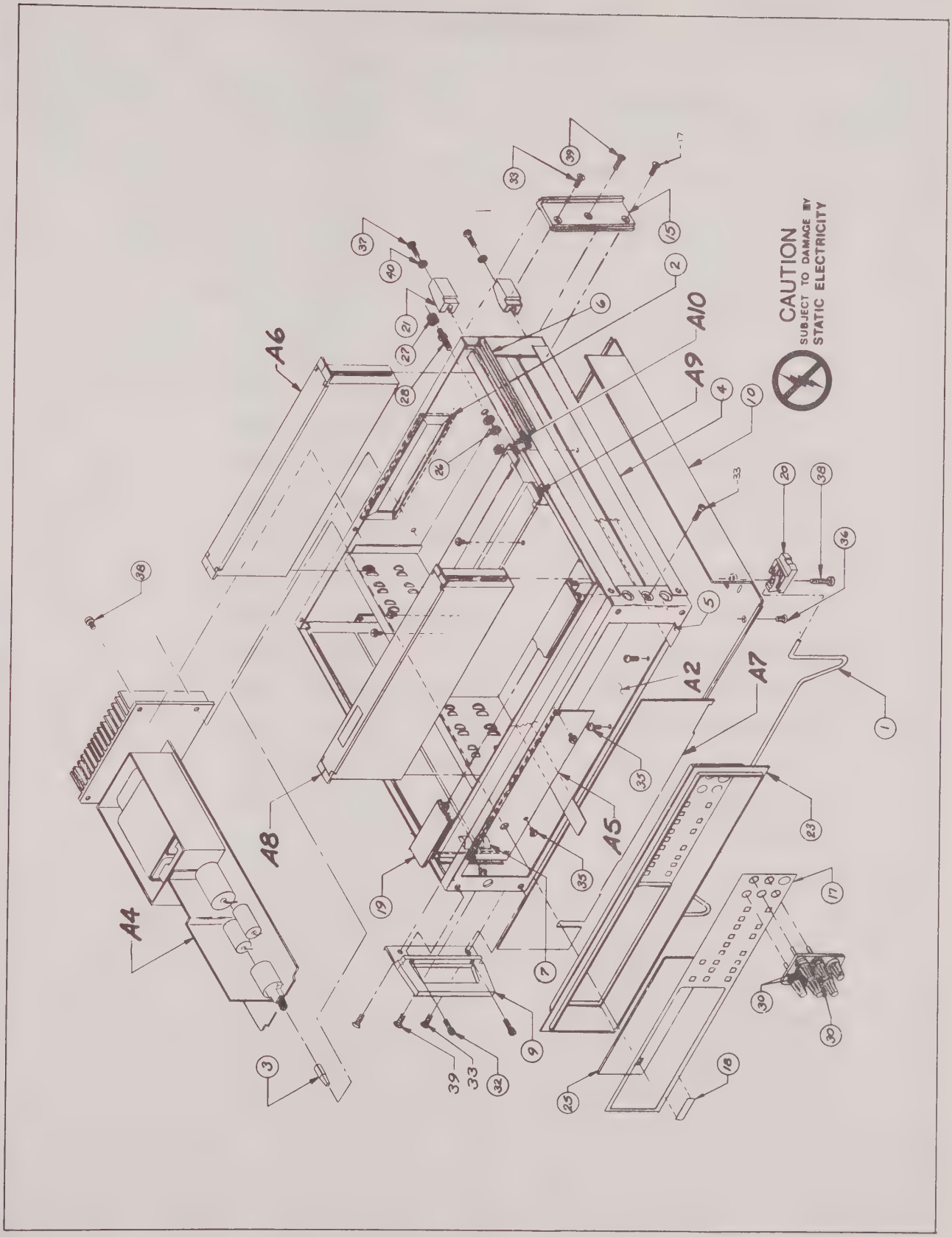


Figure 5-1. A1 Final Assembly (8500A-5001) (Sheet 2 of 2)

CHECK ERRATA

Changes #5, 21

A1 FINAL ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
12	Cover, top	383257	89536	383257	1		
13	Decal, rear panel	413369	89536	413369	1		
14	Decal, side trim, fwd	295386	89536	295386	1		
15	Decal, corner	350405	89536	350405	4		
16	Decal, handle trim	436832	89536	436832	2		
17	Decal, front panel	413351	89536	413351	1		
18	Decal, serial no.	393957	89536	393957	1		
19	Extrusion, PCB retainer	408476	89536	408476	1		
20	Foot, bail stand	292870	89536	292870	4		
21	Foot, rear panel	307363	89536	307363	2		
22	Holder, instruction book	427534	89536	427534	1		
23	Insert, front panel	381871	89536	381871	1		
24	Instruction Page Assy	444049	89536	444049	1		
25	Lens display	383380	89536	383380	1		
26	Nut, hex, double chamfer, 1/4 – 28	110619	89536	110619	1		
27	Post, binding, head grnding	225615	20584	3575	1		
28	Post, binding, grnding	225623	20584	3576	1		
29	Plug, switch	437855	89536	437855	1		
30	Shorting link	190728	83330	21171	3		
31	Screw, FH undercut, 6 – 32 x 1/4	320093	89536	320093	6		
32	Screw, cap, lo head socket #8	295105	74445	8-32UNRC	4		
33	Screw, FHP, countersunk	114116	73734	20264	8		
34	Screw, PHP, sems, 6 – 32 x 3/8	177022	89536	177022	2		
35	Screw, PHP, 4-40 x 1/4	129882	73734	19022	11		
36	Screw, FH, undercut, 6 – 32 x 1/4	320093	89536	320093	6		

A1 FINAL ASSEMBLY (Conclusion)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
37	Screw, PNA, 8 – 32 x 5/8	293324	73734	23067	2		
38	Screw, PHP, sems, 6 – 32 x 1/2	177030	89536	177030	8		
39	Screw, FHP, countersink 8 – 32 x 1/2	114355	73734	18266	4		
40	Washer, lock, int tooth, #8	110320	73734	1305	2		
41	Washer, lock, int tooth, #1/4	110817	73734	1308	1		

CHECK ERRATA

CHANGE # 8

A2 MOTHERBOARD PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	**MOTHERBOARD PCB ASSEMBLY 8500A-4001 Figure: 5-2**	459628	89536	459628	REF		
J2	Connector, bd edge recpt, 18 pin	291906	00779	583650-3	1		
J6	Connector, bd edge recpt, 20 pin	291914	00779	583650-4	1		
J7	Connector, bd edge recpt, 8 pin	354951	00779	583407-5	1		
J8, J28, J31A thru J31D	Connector, bd edge recpt, 4 pin	417550	89536	417550	6		
J11A thru J11D, J21G, J22H, J23H, J29K, J30K, J31L, J31M, J31N	Connector, bd edge recpt, 40 pin	422550	00779	2-583407-0	12		
J12A, J12B, J12C, J12D	Connector, bd edge recpt, 6 pin	291625	00779	583650-1	4		
J27	Connector, bd edge recpt, 10 pin	403964	00779	583407-6	1		
J41	Binding post, blk	275560	32767	820-45	1		
J42	Binding post, red	275552	32767	820-65	1		
R1, R2	Res, mtl film 30.9 ±1%, 1/2W	247569	91637	MFF1-23092F	2		
R3	Res, comp, 1k ±5%, 1/4W	148023	01121	CB1025	1		
R4	Res, comp, 5.6M ±5%, 2W	169821	01121	HB5655	1		
XJ2, XJ6, XJ11A, thru XJ11D, XJ21G, XJ22H, XJ23H, XJ27, XJ29K, XJ31L XJ31M, XJ31N	Polarizing insert	293498	00779	530030-1	14		

CHANGE # 20

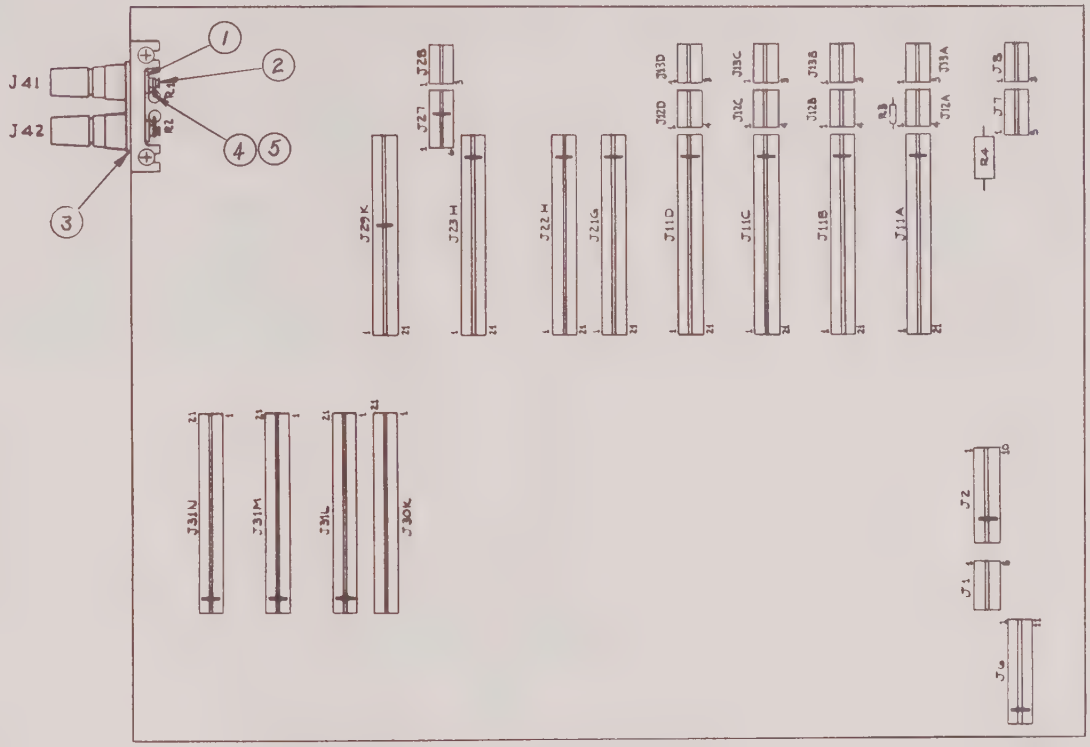


Figure 5-2. A2, Motherboard PCB Assembly

CHECK ERRATA

CHANGE #20

A2 MOTHERBOARD PCB ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
1	Nut, hex double chamfer	184044	73734	8002A-NP	2		
2	Screw, PHP, 4-40X1	157008	73734	19030	2		
3	Terminal block	419663	89536	419663	1		
4	Washer, flat #4	146225	86926	5710-18-32	2		
5	Washer, lock, int tooth	110403	73734	99402	2		

A3 BUS INTERCONNECT PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	BUS INTERCONNECT PCB ASSEMBLY (MIS-4081) Figure: 5-3	459636	89536	459636	REF		
C1, C2	Cap, Ta, 220 μf $\pm$20%, 6V	408682	56289	196D227X-0006TE4	2		
CR1	Diode, si, rect, 1 amp	343491	01295	1N4002	1		

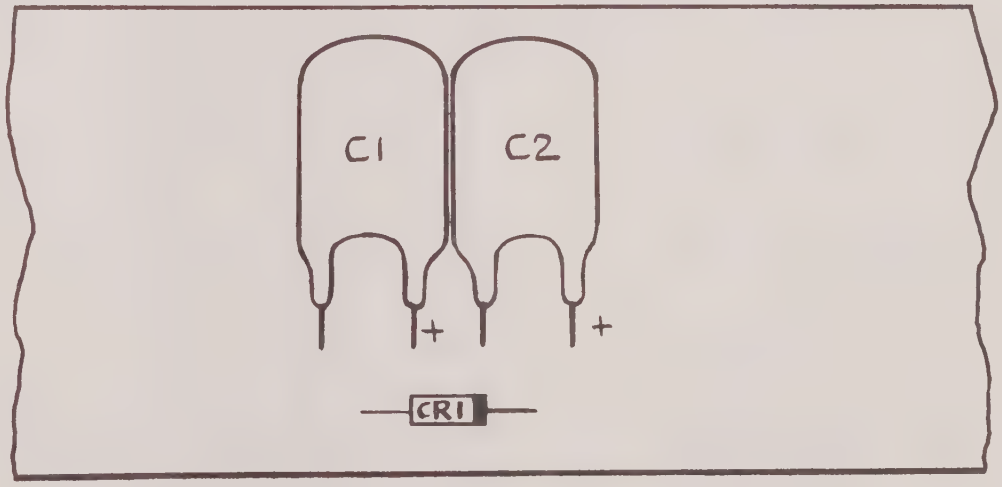


Figure 5-3. A3 Bus Interconnect PCB Assembly

CHECK ERRATA

CHANGE # 23,26

A4 POWER SUPPLY ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A4	**POWER SUPPLY ASSEMBLY 115/230V Figure: 5-4**	448860	89536	448860	REF		
A4	**POWER SUPPLY ASSEMBLY 100V Figure: 5-4**	456988	89536	456988	REF		
BR1, BR2, BR3, BR4	Bridge, Rectifier	296509	09423	FB200	4	1	
C1, C2	Cap, elect, 470 μF −10/+50%, 40V	185868	73445	ET471X040-A02	2	1	
C3, C4	Cap, elect, 220 μF −10/+50%, 40V	178616	73445	ET221X040-A01	2	1	
C5, C7	Cap, elect, 2200 μF −10/+100%, 25V	448126	12674	61C25BAS-252	2	1	
C6	Cap, elect, 4000 μF −10/+100%, 25V	370734	12674	61C25TS43	1	1	
C8	Cap, elect, 15000 μF −10/+100%, 15V	407940	12674	61C15HA153	1	1	
C9, C10 C11, C17	Cap, Ta, 5.6 μF ±20%, 25V	368969	56289	196D565X-0025KA1	4		
C12, C13, C14	Cap, cer, 0.1 μF ±20%, 100V	149146	56289	33C41B6	3		
C15, C16	Cap, cer, 0.005 ±20%, 3 kV	188003	71590	2DDH6R502M	2		
CR1, CR2, CR5	Diode, Rect, Si, 50V	347559	05277	1N5400	3	1	
CR3, CR4	Diode, Rect, Si, 100V	343491	01295	1N4002	2	1	
F1	Fuse, slo-blo, 1/2 amp	109322	71400	MDL1-2	1	5	
R1, R2	Res, comp, 3.3k ±5%, 1/4W	148056	01121	CB3325	2		
R3, R4	Res, comp. 490 ±5%, 1/4W	147975	01121	CB3915	2		
R5, R6	Res, var, cermet, 50 ±20%, 1/2W	320861	02111	62-1-1-500	2	1	
S1	Switch, slide, dpdt (115/230V)	376798	82389	11A1437	1	1	
S2	Switch, power	291526	89536	291526	1	1	
T1	Xfmr, Header Assy (115/230V)	450403	89536	450403	1		
T1	Xfmr, Header Assy (100V)	456350	89536	456350	1		
U1, U3	IC, lin, vol reg	413187	04713	MC7815CP	2	1	

CHECK ERRATA
CHANGE # 26

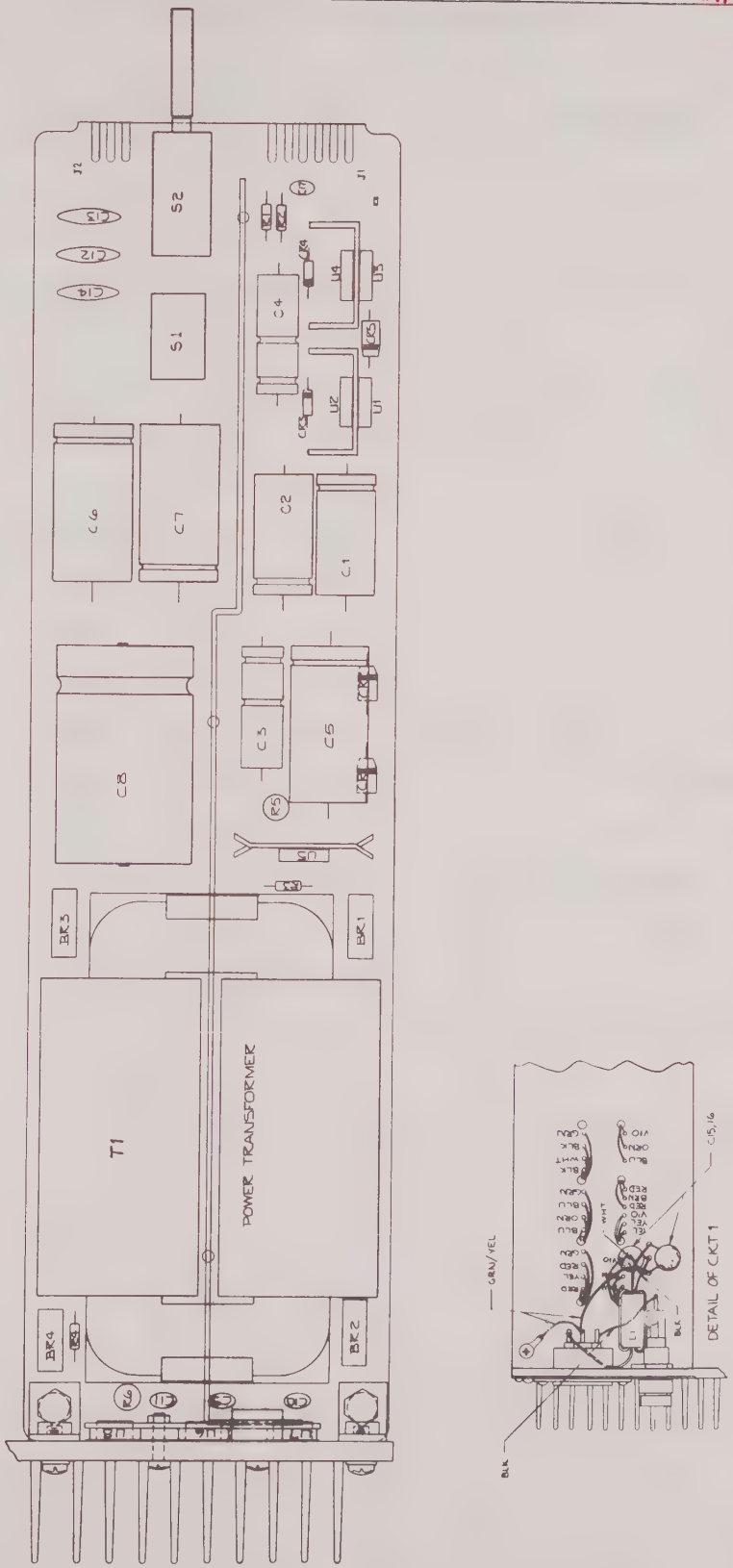


Figure 5-4. A4, Power Supply PCB Assembly

CHANGE # 14

A5 POWER SUPPLY ASSEMBLY (Conclusion)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U2, U4	IC, lin, neg, vol reg	413179	04713	MC7915CP	2	1	
U5	IC, lin, vol reg	355107	04713	MC7805CP	1	1	
U6	IC, lin, vol reg	428854	04713	MC7812CP	1	1	
U7	IC, lin, neg, vol reg	381665	04713	MC7912CP	1	1	
U8	IC, lin, vol reg	428847	04713	MC7805CP	1	1	
XF1	Fuseholder	435628	89536	435628	1		
	Connector, pwr, recpt	284166	82389	EAC301	1		
1	Decal	386250	89536	386250	1		
	Extrusion	416974	89536	416974	1		
	Ferrite, Core	420588	89536	429588	1		
	Heat Dissipator (use with U1, U2, U3, U4)	414128	13103	6030B-TT	2		
	Heatsink (use with U5)	386235	13103	6032D	1		
	Insulator, power switch	383153	89536	383153	1		
	Insulator, semiconductor mtg	428821	55285	7403-10-51	5		
	Insulator Gasket	436824	89536	436824	1		
	Nutplate	420448	89536	420448	1		
	Socket, IC, (use with U6, U7, U8)	402958	27264	10-18-2031	3		
1	The following items not shown.						

A5 POWER SUPPLY INTERCONNECT ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5	**POWER SUPPLY INTERCONNECT ASSEMBLY 8500A-4032**	401760	89536	401760	REF		
P1	Connector, bd edge, recpt	291625	00779	583650-1	1		
P2	Connector, bd edge, recpt	352682	00779	583694-2	1		
	NOTE: *See figure 5-1 (sheet 2 of 2) for location. Not Illustrated separately.*						

CHECK ERRATA

CHANGE #2, 6, 9, 29

A6/A6A1 CONTROLLER PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A6 Ⓧ	**CONTROLLER ASSEMBLY, TESTED MODULE 8500A-4185T** **Figure: 5-5**	384107	89536	384107	REF		
U7	IC, dgtl, MOS, N-channel, Si-gate	428813	89536	428813	1	1	
U10	IC, dgtl, MOS, N-channel, Si-gate CPU, 8-bit parallel	404541	01295	TMS8080	1	1	
U22	IC, dgtl, MOS, N-channel, Si-gate	418422	89536	418422	1	1	
U25	IC, dgtl, MOS N-channel, Si-gate	413252	89536	413252	1	1	
U33	IC, dgtl, MOS N-channel, Si-gate	418020	89536	418020	1	1	
1	Case, half, module	402990	89536	402990	2		
	Case, cover module (Not Shown)	402974	89536	402974	1		
	Decal (Not Shown)	413542	89536	413542	1		
A6A1 Ⓧ	**CONTROLLER PCB ASSEMBLY**						
C1	Cap, mica, 15 pF ±5%, 500V	148569	72136	DM15C150J	1		
C2	Cap, mica, 47 pF ±5%, 500V	148536	72136	DM15E470J	1		
C3, C4, C5, C7 C11 thru C17, C20, C21, C23, C32	Cap, cer, 10,000 pF ±20%, 100V	407361	72982	8131-A100-W5 R-103M	15		
C6, C28	Cap, cer 0.022 μF −20/+100%, 40V	358325	72982	8121-A050-651-223Z	2		
C8, C9	Cap, mica, 4 pF ±0.5 pF, 500V	190397	72136	DM15C040E	2		
C10	Cap, cer, 1 μF ±20%, 50V	436782	51642	300-050-601-105M	1		
C18	Cap, Ta, 15 μF ±20%, 6V	161935	56289	196D156X-0006-KA1	1		
C19	Cap, cer, 0.22 μF ±20%, 50V	309849	71590	CW30C224K	1		
C22	Cap, elect, Ta, 1 μF ±5%, 15V	461152	56289	150D106X-5015A2	1	1	
C24, C27	Cap, mica, 33 pF ±5%, 500V	160317	72136	DM15E330J	2		
C25	Cap, Ta, 39 μF ±20%, 6V	163915	56289	196D396X-0006	1		

A6A1 CONTROLLER PCB ASSEMBLY (Continued) CHANGE #19

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C26	Cap, cer, 2200 pF ±10%, 500V	268425	72982	851-000-Z5R-222K	1		
C29, C30, C31	Cap, Ta, 2.2 μF ±20%, 20V	161927	56289	196D225X-0020HA1	3		
C33	Cap, Ta, 150 μF ±20%, 6V	460204	56289	183DR157X 0006F	1		
CR1	Diode, hi-speed, switching	203323	07910	1N4448	1		
R1	Res, var, cermet, 10k ±10%, 1/2W	285171	89536	285171	1	1	
R2, R17, R25, R28	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	4		
R3, R8, R9, R10, R11, R16	Res, comp, 4.7k ±5%, 1/4W	148072	01121	CB4725	6		

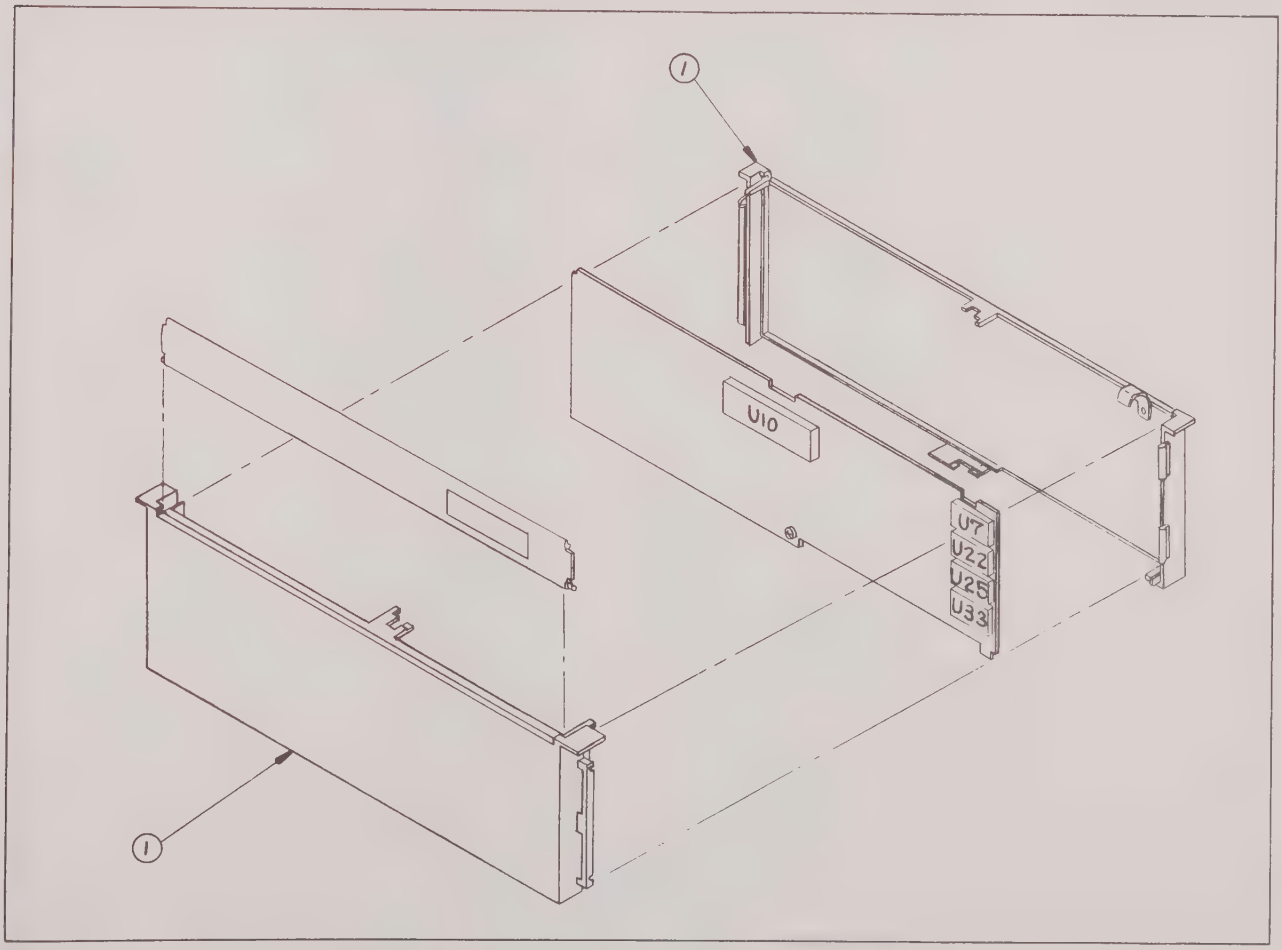


Figure 5-5. A6, Controller Module Assembly (Sheet 1 of 2)

CHECK ERRATA

CHANGE #19

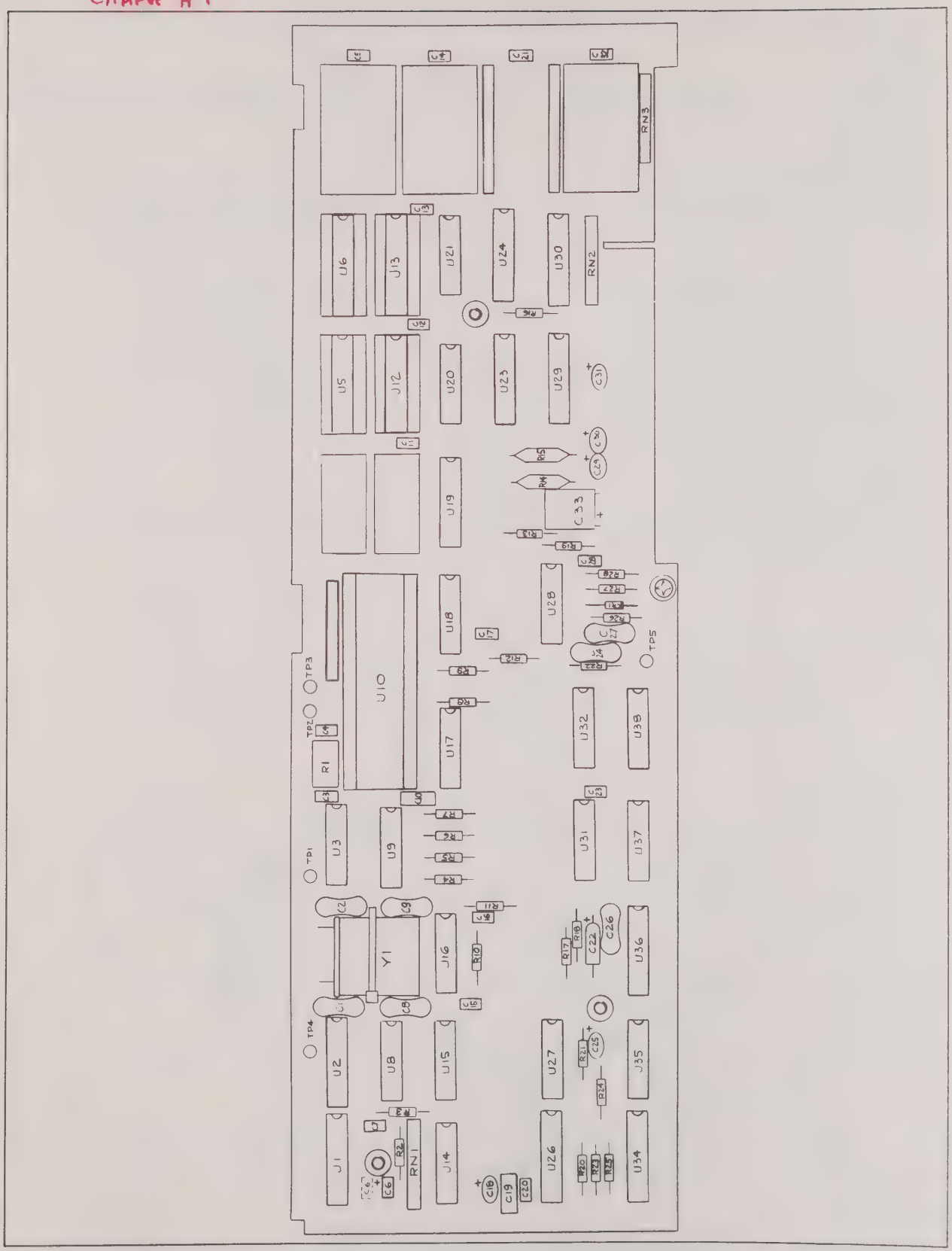


Figure 5-5. A6A1, Controller PCB Assembly (Sheet 2 of 2)

CHECK ERRATA 1

A6A1 CONTROLLER PCB ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R4, R7, R19, R27	Rex, comp, 2k ±5%, 1/4W	202879	01121	CB2025	4		
R5, R21	Res, comp, 6.8k ±5%, 1/4W	148098	01121	CB6825	2		
R6	Res, comp, 10M ±5%, 1/4W	194944	01121	CB1065	1		
R12, R13, R20	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	3		
R14	Res, mf, 715 ±1%, 1/8W	313080	91637	MFF1-87150F	1		
R15	Res, mf, 523 ±0.5%, 1/8W	294835	91637	MFF1-85230D	1		
R18	Res, mtl film, 23.2k ±1%, 1/8W	291351	91637	CMF552322F	1		
R22	Res, comp, 3k ±5%, 1/4W	193508	01121	CB3025	1		
R23	Res, comp, 680k ±5%, 1/4W	188433	01121	CB6845	1		
R24	Res, comp, 1.5k ±5%, 1/4W	148031	01121	CB1525	1		
R26	Res, comp, 30k ±5%, 1/4W	193417	01121	CB3035	1		
RN1, RN2	Res Network	412916	89536	412916	2	1	
RN3	Res Network	412924	89536	412924	1	1	
U1	IC, Dgtl, TTL, LPS, dual J-K flip-flop	412999	01295	SN74LS109N	1	1	
U2	⊗ IC, Dgtl, C-MOS, hex, buffer/inverters	381830	02735	CD4050AE	1	1	
U3	⊗ IC, Dgtl, C-MOS, fast, quad 2-input, NAND gate	413211	07263	34011PC64011 PC	1	1	
U5, U6, U12, U13	⊗ IC, Dgtl, MOS, 1024 bit, static RAM	404558	34649	P2111-1	4	1	
U8	IC, Dgtl, TTL, AND-OR, invert gates	412981	01295	SN74LS51	1	1	
U9	⊗ IC, Dgtl, C-MOS, hex inverter	404699	12040	MM74C04N	1	1	
U14, U35	⊗ IC, C-MOS, dual, type "D" flip-flop	340117	04713	MC14013CP	2	1	
U15	IC, Dgtl, TTL, quad 2-input, pos, AND gates	393066	01295	SN74LS08	1	1	
U16, U21	IC, Dgtl, TTL, hex inverter, pos NAND gates	393058	01295	SN74LS04	2	1	
U17	⊗ IC, Dgtl, C-MOS, quad 2-input, NAND gates	375147	02735	CD4023AE	1	1	
U18	IC, Dgtl, TTL, hex/quad, D type flip-flop, w/c	393207	01295	SN74LS174N	1	1	

A6A1 CONTROLLER PCB ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U19, U29	⊗ IC, Dgtl, C-MOS, strobed, hex inverter/ buffer	408211	04713	MC14502CP	2	1	
U20	IC, Dgtl, TTL, 2-independent, 2-4line, dcdr/multiplxr	393165	01295	SN74LS139N	1	1	
U23, U24, U30	⊗ IC, Dgtl, C-MOS, Tri-State NON-inverting buffers	407759	12040	MM80C97N	3	1	
U26	⊗ IC, lin, COS/MOS, phase locked loop	403584	02735	CD4046AE	1	1	
U27	⊗ IC, Dgtl, C-MOS, quad 2-input, OR gate	408393	02735	CD4071BE	1	1	
U28	⊗ IC, Dgtl, C-MOS, 8-bit, priority encoder	412973	02735	CD4523BE	1	1	
U31	IC, Dgtl, TTL, triple-input, POS NAND gates and inverters	393074	01295	SN74LS10N	1	1	
U32	⊗ IC, Dgtl, C-MOS, hex inverter	404681	02735	CD4069BE	1	1	
U34	⊗ IC, Dgtl, C-MOS, dual, up-counter	355164	04713	MC14520CL/CP	1	1	
U36	⊗ IC, Dgtl, C-MOS, retriggerable/resettable monostable multivibrator	454017	04713	MC14538BCP	1	1	
U37	⊗ IC, Dgtl, C-MOS, quad 2-input NOR gates	429944	02735	CD4001BE	1	1	
U38	⊗ IC, Dgtl, C-MOS, quad 2-input NAND	404632	02735	CD4039BE	1	1	
Y1	Crystal, quartz	412932	89536	412932	1		
1	Clamp, nylon strap	172080	06383	SST1M	1		
	Guard, front	383356	89536	383356	1		
	Guard, rear	383364	89536	383364	1		
	Shield, cover	440008	89536	440008	1		
	Socket, IC, 18 pins	418228	91506	318-AG39D	6		
	Socket, IC, 24 pins	418970	91506	324-SG39D	3		
	Socket, IC, 40 pins	418988	91506	340-AG39D	1		
	Socket, IC, 9 pins	436774	30035	SS-109-1-09	1		
	Socket, IC, 12 pins	417733	30035	SS-109-1-12	2		
1	Not Shown						

A7 DISPLAY PCB ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A7	**DISPLAY PCB ASSEMBLY (8500A-4021) Figure: 5-6**	384032	89536	384032	REF		
C1	Cap, cer, 0.22 uF ±20%, 50V	309849	71590	CW30C224K	1		
C2	Cap, Ta, 5.6 uF ±20%, 25V	368969	56289	196D565X0025 KA1	1		
C3	Cap, cer, 1200 pF ±20%, 100V	358283	80031	2222-630-01-122	1		
CR1 thru CR4	Diode Hi-speed Switching	203323	07910	1N4448	4	1	
CR7	Diode, LED	413831	29083	MV5153	1	1	
F1	Fuse, fast-blo	109330	71400	AGC11-2	1	5	
J1, J2	Binding Post, red	275552	32767	820-65	2		
J3, J4	Binding Post, blk	275560	32767	820-45	2		
J5	Binding Post, blue	275578	32767	820-55	1		
L1	Coil Assembly	438325	89536	438325	1		
Q1	Xstr, Si, NPN	330803	04713	MPS6560	1	1	
Q2 thru Q8	Xstr, Si, PNP	340026	04713	MPS6563	7	2	
Q10	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
R1	Res, comp, 62 ±5%, 1/4W	261842	01221	CB6205	1		
R2, R6	Res, comp, 200 ±5%, 1/4W	193482	01121	CB2015	2		
R3	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	1		
R4	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R5	Res, comp, 4.7k ±5%, 1/4W	148072	01121	CB4725	1		
R7	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	1		
R8	Res, comp, 10M ±5%, 1/4W	194944	01121	CB1065	1		
S1 thru S8, S10 thru S18	Switch, actuator	412106	89536	412106	17		

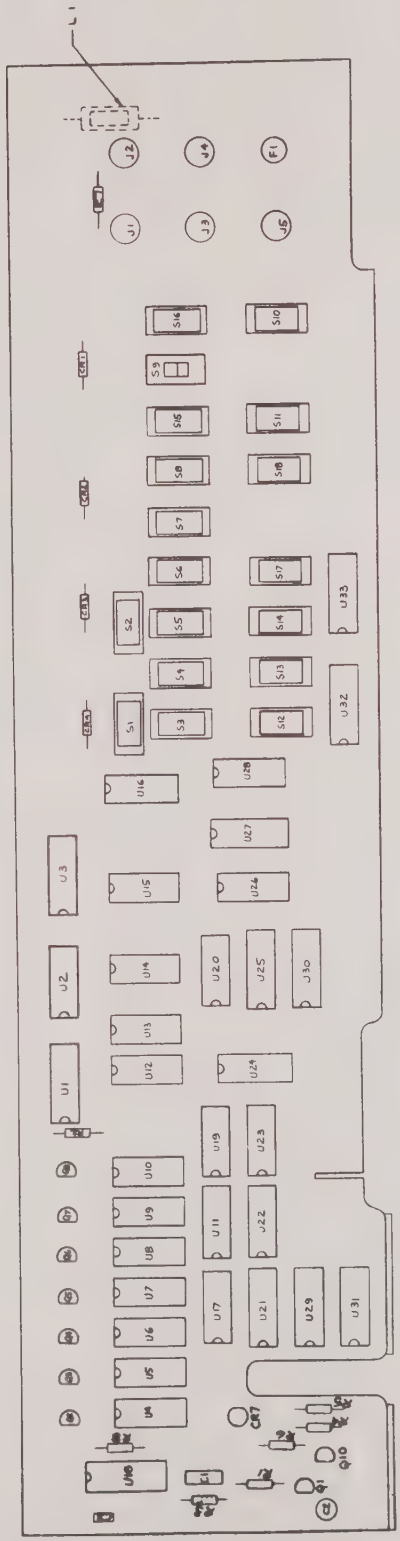


Figure 5-6. A7, Display PCB Assembly

A7 DISPLAY PCB ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
S1 thru S8, S10 thru S18	Switch, top cover	401299	89536	401299	17		
S1 thru S8, S10 thru S18	Spring, switch, pushbutton	414516	00779	62353-3	17		
S1 thru S8, S10 thru S18	Contact, switch, pushbutton	416875	00779	62380-4	17		
S1 thru S5, S15 thru S17	SW, pushbutton, lt putty grey	401307	89536	401307	8		
S6, S7, S8, S12, S13, S14	SW, pushbutton, dk putty grey	406728	89536	406728	6		
S9	Switch Slide, spdt	417287	95146	MSS-104D-1	1		
S10, S11	Pushbutton, med, yellow, sw	419937	89536	419937	2		
S18	Pushbutton, blue, sw	406736	89536	406736	1		
U1, U21, U25	IC, lin, NPN, xstr array	407866	02735	CA3081	3	1	
U2	⊗ IC, C-MOS, hex inverter	404681	02735	CD4069BE	1	1	
U3, U27, U31	⊗ IC, C-MOS, hex "D" flip-flop	404509	12040	MM74C174N	3	1	
U4, U12	Display, LED	453282	29083	MAN4630A	2	1	
U5 thru U10, U13	Display Set	440016	89536	440016	1	1	
U11	⊗ IC, Dig, C-MOS, quad, 2-input NAND gate	355198	02735	CD4011AE	1	1	
U14, U15, U24, U26	Display, LED	453274	29083	MAN4610A	4	1	
U16, U22 U23	⊗ IC, C-MOS, dual, flip-flop	340117	04713	MC14013CL	3	1	
U17, U20	Res Network 4.7k	344069	89536	344069	2	1	
U18	⊗ IC, Dig, C-MOS, retriggerable/resettable monostable/multivibrator	393512	04713	MC14528CP	1	1	

CHECK ERRATA
CHANGE #9

A7 DISPLAY PCB ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U19	Ⓧ IC, C-MOS, dual 4-input, NAND gate	355206	04713	MC14012CP	1	1	
U28	Ⓧ IC, C-MOS, triple 3-input NAND gate	375147	04713	MC14023CP	1	1	
U29, U30	Res, dual, in-line package	358119	89536	358119	2	1	
U32	Ⓧ IC, C-MOS, tri-state, hex non-inverting buffer	407759	12040	MM80C97N	1	1	
U33	Res Network	386961	89536	386961	1	1	
1	Cap, fuse	455857	89536	455857	1		
	Fuseholder	435628	89536	435628	1		
	Insulator Binding Post	449363	89536	449363	1		
	Mask LED	418996	89536	418996	4		
	Shield Front Panel	433524	89536	433524	1		
	Socket, IC	453514	71785	133-59-90-0901/ 14E	13		
	Spacer	446641	11897	167-PB-0588	1		
	Spark Gap	442731	25088	B1C145	1		
1	Not Shown						

CHECK ERRATA # 7

CHANGE # 16,22

A8 D.C. SIGNAL CONDITIONER ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A8 Ⓧ	**D.C. SIGNAL CONDITIONER ASSEMBLY (MIS-4100) (Tested)** **Figure: 5-7**	383901	89536	383901	REF		
C1, C2	Cap, Ta, 5.6 uF ±20%, 25V	368969	56289	196D565X0025 KA1	2		
C3, C4	Cap, cer, 0.22 uF ±20%, 50V	309849	71590	CW30C224K	2		
C5	Cap, Ta, 39 uF ±20%, 6V	163915	56289	196D396X0006 KA1	1		
C10, C11	Cap, elect, 6.8 uF –10/+50%, 63V	218966	73445	ET6P8X063A3	2	1	
C12, C14	Cap, mica, 100 pF ±5%, 500V	148494	72136	DM15F101J	2		
C13	Cap, cer, 0.01 uF ±	149153	56289	33C41B6	1		
C15, C16	Cap, mica, 47 pF ±5%, 500V	148536	72136	DM15E470J	2		
C18, C19	Cap, cer, 33 pF ±2%, 100V	354852	80031	2222-638-10339	2		
CR1, CR2	Diode, Hi-speed switching	203323	07910	1N4448	2	1	
CR3, CR4	Diode, zener	181073	07910	1N969B	2	1	
K1, K2	Relay, armature, lo-profile	515437 ~~441261~~	77342	R40-E0186-1	2		
Q1, Q3	Xstr, NPN, Si	330803	07263	MPS6560	2	1	
Q2, Q4, Q6, Q31, Q33, Q35	Xstr, PNP, Si	195974	04713	2N3906	6	2	
Q5	Xstr, PNP, Si	226290	04713	MPS3640	1	1	
Q7, Q10 thru Q13, Q22, Q23, Q32, Q34, Q36, Q38	Xstr, NPN, Si	218396	04713	2N3904	11	3	
Q8, Q14, Q15, Q16	Xstr, FET, N-channel	393314	89536	393314	4	1	
Q18	Xstr, NPN, Si	284075	32293	IT1099	1	1	
Q19	Xstr, NPN, Si	295717	24355	AD811-00/17	1	1	
Q37	Xstr, PNP, Si	218388	07263	2N3645	1	1	

CHECK ERRATA

CHANGE # 22

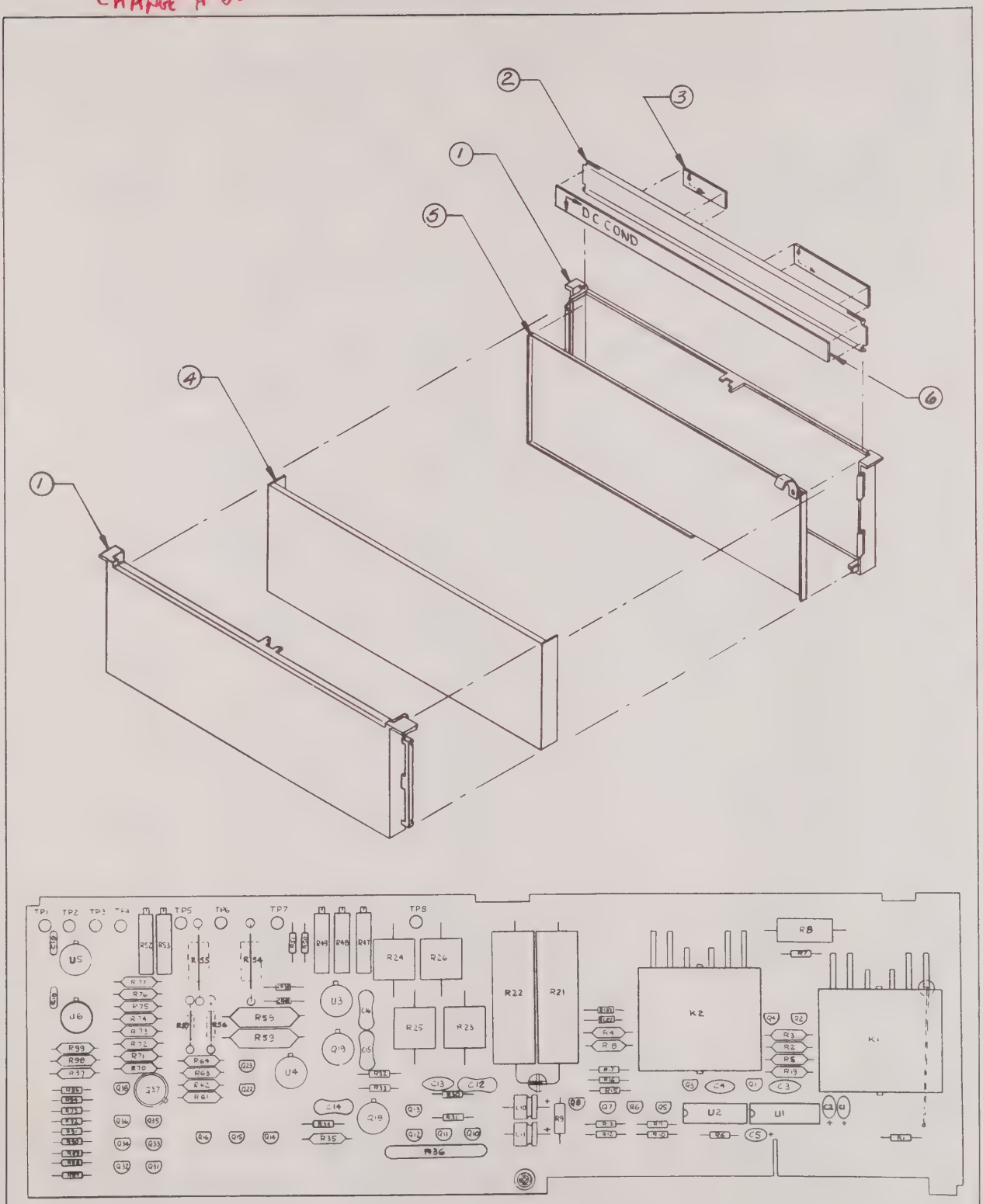


Figure 5-7. A8, D.C. Signal Cond. Case and PCB Assembly

A8 D.C. SIGNAL CONDITIONER PCB ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R1	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	1		
R2, R3	Res, mf, 28.0k ±1%, 1/8W	291385	91637	MFF1-82802F	2		
R4, R18	Res, mf, 21k ±1%, 1/8W	441212	91637	MFF1-82102F	2		
R5, R19	Res, mf, 17.8k ±1%, 1/8W	349183	91637	MFF1-81782F	2		
R6	Res, car, dep, 470 ±5%, 1/4W	343434	80031	CR251-45P471T	1		
R7, R31, R32, R33, R34	Res, car, dep, 10k ±5%, 1/4W	348839	80031	CR251-45P103T	5		
R8	Res, comp, 150k ±5%, 2W	110122	01121	HB1545	1		
R9	Res, comp, 150k ±10%, 1/2W	108167	01121	EB15415	1		
R10	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R11	Res, comp, 47k ±5%, 1/4W	148163	01121	CB4735	1		
R12, R13	Res, comp, 15 ±5%, 1/4W	147876	01121	CB1505	2		
R15, R93, R94, R95	Res, car, dep, 1M ±5%, 1/4W	348987	80031	CR251-45P105T	4		
R16, R17, R87, R88, R89, R90, R91, R92	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	8		
R21, R22, R23	Res, divider set	434605	89536	434605	1	1	
R24, R25, R26	Res, DC range set	409938	89536	409938	1	1	
R30	Res, car dep, 15k ±5%, 1/4W	348854	80031	CR251-45P153T	1		
R35, R62	Res, mf, 1M ±1%, 1/8W	268797	91637	MFF1-81004F	2		
R36	Res, cermet, 100M ±10%, 1W	441758	89536	441758	1		
R47	Res, var, 200 ±20%, 1/2W	284711	71450	190PC201B	1	1	
R48, R49	Res, var, cermet, 50 ±20%, 1/2W	267815	71450	190PC500B	2	1	
R50	Res, car, dep, 2.2 ±5%, 1/4W	354944	80031	CR251-45P2E2T	1		
R51	Res, car, dep, 20 ±5%, 1/4W	442202	80031	CR251-45P20ET	1		
R52	Res, var, cermet, 100k ±20%, 1/2W	268581	71450	190PC104B	1	1	

CHECK ERRATA # 7

CHANGE #1, 18

A8 D.C. SIGNAL CONDITIONER PCB ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R53	Res, var, cermet, 10k ±20%, 1/2W	267880	71450	190PC103B	1	1	
R54, R55, R56, R57	Res, selected, during test				4	1	
R58, R59	Res, set, matched	290230	89536	290230	1	1	
R61	Res, mf, 86.6k ±1%, 1/8W	291468	91637	MFF1-88662F	1		
R63	Res, mf, 1.87k ±1%, 1/8W	267229	91637	MFF1-81871F	1		
R64	Res, mf, 1k ±1%, 1/8W	168229	91637	MFF1-81002F	1		
R70	Res, mf, 52.3k ±1%, 1/8W	237248	91637	MFF1-85232	1		
R71	Res, mf, 3.01k ±1%, 1/8W	312645	91637	MFF1-83011F	1		
R72, R97	Res, mf, 3.65k ±1%, 1/8W	293779	91637	MFF1-83651F	2		
R73, R74	Res, mf, 100k ±1%, 1/8W	248807	91637	MFF1-81003F	2		
R75, R99	Res, mf, 80.6k ±1%, 1/8W	281121	91637	MFF1-88062F	2		
R76	Res, mf, 4.02 ±1%, 1/8W	235235	91637	MFF1-84021F	1		
R77	Res, mf, 200k ±1%, 1/8W	261701	91637	MFF1-82003F	1		
R98	Res, mf, 2.15k ±1%, 1/8W	293712	91637	MFF1-82151F	1		
U1	⊗ IC, Dgtl, COS/MOS, quad clocked "D" latch	355149	02735	CD4042AE	1	1	
U2	⊗ IC, Dgtl, C-MOS, triple, 3-input, NAND gates	375147	02735	CD4023AE	1	1	
U3, U4	IC, Op Amp, J-FET, input	310037	12040	LH0042CA	2	1	
U5, U6	IC, Op, Amp	271502	12040	LM301A	2	1	
1	Case Half	402990	89536	402990	2		
2	Cover	402974	89536	402974	1		
3	Decal	413377	89536	413377	1		
4	Guard, front	383356	89536	383356	1		
5	Guard, rear	383364	89536	383364	1		
6	Shield, cover	411918	89536	411918	1		
	Socket, spring type (Not Shown)	343285	00779	2-331272-6	8		
	Spacer, transipad (use with Q37) (Not Shown)	152207	07047	10123-DAP	1		
	Spacer (Not Shown)	334797	32559	T0-35-15	1		
	Terminal, feed-thru (Not Shown)	281865	12615	SL-841-777	1		

A9 ACTIVE FILTER ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A9 Ⓢ	**ACTIVE FILTER ASSEMBLY** **Figure: 5-8 (M.I.S.4130) Tested**	383745	89536	383745	REF		
C1, C2, C3	Cap, polyprop, 0.047 uF ±10%, 50V	413328	89536	413328	3		
C4, C8, C9, C10	Cap, mica, 33 pF ±5%, 500V	160317	72136	DM15E330J	4		
C5, C6, C7	Cap, polyprop, 0.47 uF ±10%, 50V	363085	89536	363085	3		
C11, C14	Cap, elect, 6.8 uF −10/+50%, 6.3V	218966	73445	ET6P8X063A3	2	1	
C12, C13	Cap, elect, 10 uF −10/+50%, 25V	170266	73445	ET100X25A2	2	1	
C15	Cap. polyprop, 0.0022 ±10%, 200	442632	89536	442632	1	1	
CR1	Diode, zener	260695	07910	1N754A	1	1	
CR2	Diode, zener	386557	07910	1N960A	1	1	
CR3	Diode, zener	203323	07910	1N4448	1	1	
Q1, Q3, Q5, Q7, Q9, Q11	Xstr, Si, PNP	195974	04713	2N3906	6	2	
Q2, Q4, Q6, Q8, Q10, Q12, Q28, Q29, Q30	Xstr, Si, NPN	218396	04713	2N3904	9	2	
Q13	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
Q14 thru Q25, Q31, Q32	Xstr, FET, N-channel	393314	89536	393314	14	3	
Q26	Xstr, Si, PNP	218388	07263	2N3645	1	1	
Q27	Xstr, Si, NPN	284075	32293	IT1099	1	1	
R1	Res, carbon, dep, 6.2k ±5%, 1/4W	442368	80031	CR251-45P622T	1		
R2	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R3	Res, mf, 51.1k ±5%, 1/8W	289553	91637	MFF1-85112F	1		
R4, R5	Res, comp, 8.2k ±5%, 1/4W	160796	01121	CB8225	2		
R8 thru R11	Res, mf 45.3k ±1%, 1/8W	234971	91637	MFF1-84532F	4		

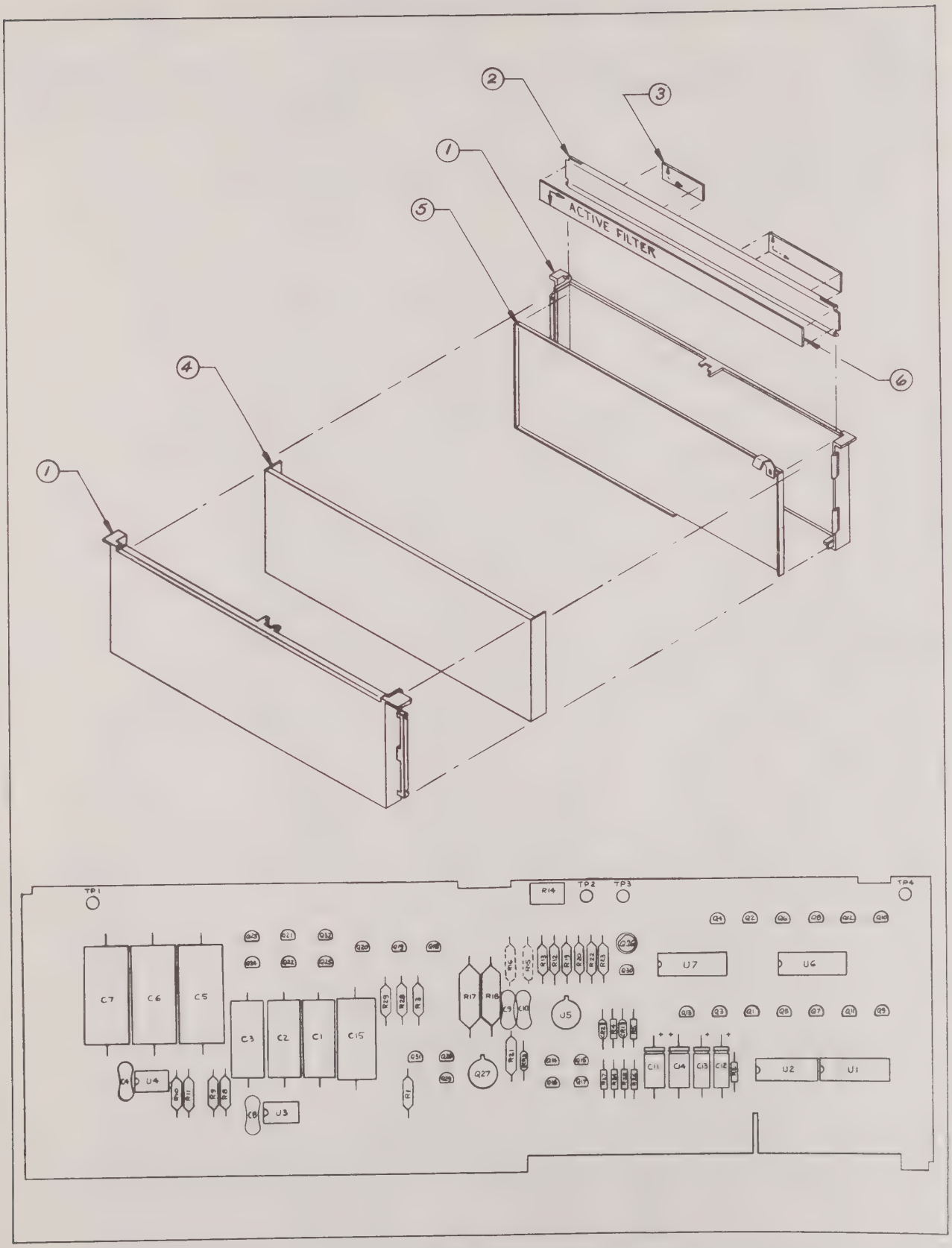


Figure 5-8. A9, Active Filter Case and PCB Assembly

CHECK ERRATA 7

A9 ACTIVE FILTER ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R12, R19, R22	Res, mf, 12.1k ±1%, 1/8W	234997	91637	MFF1-81212F	3		
R13	Res, mf, 4.87k ±1%, 1/8W	294850	91637	MFF1-84871F	1		
R14	Res, var, cermet, 20k ±10%, 1/2W	291609	89536	291609	1	1	
R15, R16	Res, selected, during test						
R17, R18	Res, mf, 1M ±1%, 1/2W	327510	91637	MFF1-21004F	2		
R20, R23	Res, mf, 249k ±1%, 1/8W	268805	91637	MFF1-82493F	2		
R21	Res, mf, 57.6k ±1%, 1/8W	289116	91637	MFF1-85762F	1		
R24, R27	Res, comp, 15 ±5%, 1/4W	147876	01121	CB1505	2		
R25, R26	Res, comp, 100 ±5%, 1/4W	147926	01121	CB1015	2		
R28, R29	Res, mf, 26.7k ±1%, 1/8W	245779	91637	MFF1-82672F	2		
U1	⊗ IC, Dgtl, C-MOS, hex, "D" flip-flop	404509	12040	MM74C174N	1	1	
U2	⊗ IC, Dgtl, C-MOS, triple , 3-input NAND gates	375147	02735	CD4023AE	1	1	
U3, U4	IC, lin, op-amp	363515	12040	LM301AN	2	1	
U5	IC, lin, op-amp	392902	12040	LM1346H	1	1	
U6	Res Network, 100k ±10%, 1/4W	404749	89536	404749	1	1	
U7	Res Network, 100k ±10%, 10V	380618	89536	380618	1	1	
1	Case Half	402990	89536	402990	2		
2	Cover	402974	89536	402974	1		
3	Decal	413443	89536	413443	1		
4	Guard, front	383356	89536	383356	1		
5	Guard, rear	383364	89536	383364	1		
6	Shield, cover	411959	89536	411959	1		
	Socket, spring type (Use with R15, R16) (Not Shown)	343285	00779	2-331272-6	4		
	Spacer (Use with Q26) (Not Shown)	152207	07047	10123DAP	1		

CHECK ERRATA

CHANGE # 12

A10 FAST R² A/D CONVERTER ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10 Ⓧ	**FAST R² A/D CONVERTER ASSEMBLY**						
A10A1	A/D Analog Assembly (MIS-4140)	383752	89536	383752	1		
A10A2	Ⓧ A/D Digital Assembly (MIS-4141)	383760	89536	383760	1		
A10A1	**A/D ANALOG ASSEMBLY** **Figures: 5-9 and 5-10**						
C1, C2	Cap, Ta, 10 μF ±20%, 35V	417683	56289	196D106X 0035KA1	2		
C3	Cap, mica, 33 pF ±5%, 500V	160317	72136	DM15E330J	1		
C4	Cap, mica, 30 pF ±5%, 500V	340570	72136	DM15E300J	1		
C5	Cap, film, 0.22 μF±10%, 80V	159392	56289	192P2249R8	1		
C6	Cap, Ta, 4.7 μF ±20%, 25V	161943	56289	196D475X 0025KA1	1		
C7, C8	Cap, mica, 150 pF ±5%, 500V	148478	72136	DM15F151J	2		
C9, C10	Cap, polyst, 0.047 μF ±10%, 100V	260562	84411	863UW47391	2		
C11, C12, C14	Cap, mica, 47 pF ±5%, 500V	148536	72136	DM15E470J	3		
C13	Cap, elect, 470 μF −10/+50%, 6.3V	187773	73445	ET471X6P3A6	1	1	
C15	Cap, cer, 0.0047 μF ±10%, 500V	106724	71590	CF-472	1		
C16, C17	Cap, cer, 0.22 μF ±20%, 50V	309849	71590	CW30C224K	2		
C20	Cap, Ta, 0.22 μF ±20%, 35V	161331	56289	196D224X 0035HA1	1		
C21	Cap, mica, 1800 pF ±5%, 500V	148353	72136	DM19F182J	1		
CR1, CR9	Diode, Hi-speed, switching	203323	07910	1N4448	2	1	
CR3, CR4, CR7, CR8	Diode, Si lo-cap, lo-leak	348177	07263	FD7223	4	1	
CR5, CR6	Diode, Si, controller fwd vol	234468	07910	TD9039	2	1	
J1, J2	Socket I	276535	91506	316-AG39D	2		
Q1, Q2 Q3, Q11 thru Q16, Q25, Q26	Xstr, FET, set (selected	256487	89536	256487	1	1	
Q4 thru Q8	Xstr, FET, N-channel	343830	89536	343830	5	1	
C18	Cap, Ta, 68 μF ±20%, 25V	446450	56289	196D686X 0025TE4	1		

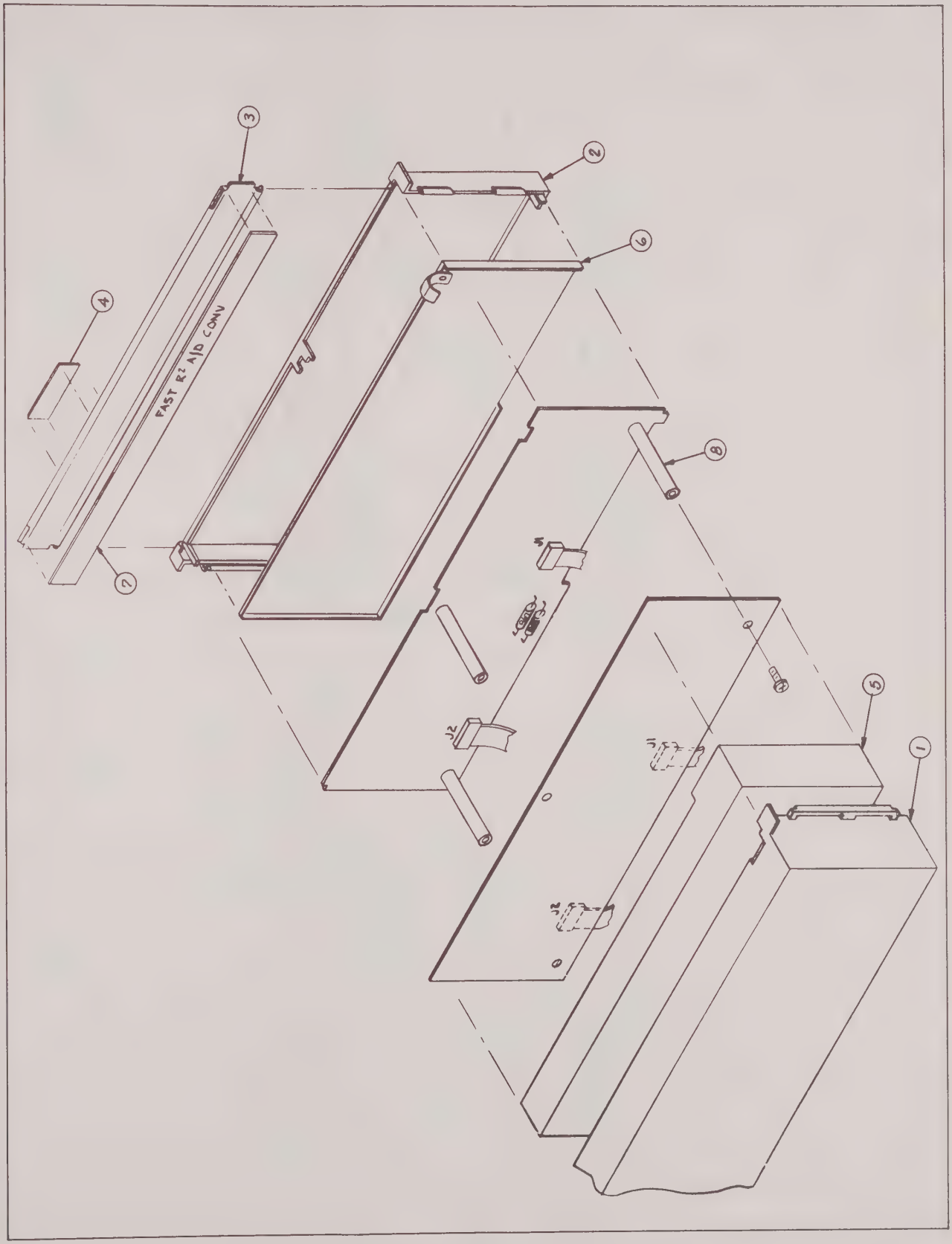


Figure 5-9. A10 Fast R^2 A/D Converter Case Assembly

CHECK ERRATA

CHANGE #12

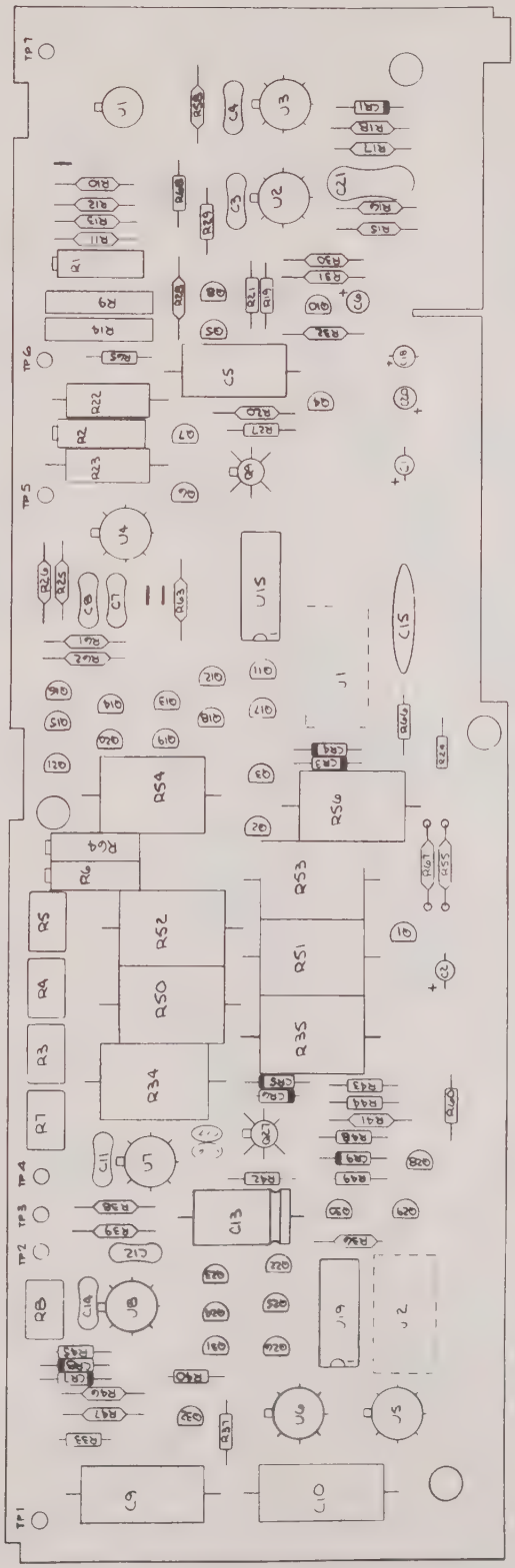


Figure 5-10. A10A1, Fast R² A/D Converter (Analog) PCB Assembly

CHECK ERRATA

A10A1 FAST R² A/D CONVERTER ANALOG ASSEMBLY (Continued) CHANGE #31

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q9, Q27	Xstr, FET, dual, N-channel	376087	89536	376087	2	1	
Q10	Xstr, Si, NPN	218396	04713	2N3904	1	1	
Q17 thru Q24, Q29 thru Q32	Xstr, FET, N-channel	261578	89536	261578	12	3	
Q28	Xstr, Si, PNP	195974	04713	2N3906	1	1	
R1	Res, var, cermet, 500 ±20%, 1/2W	267849	75378	190PC501B	1	1	
R2, R64	Res, var, cermet, 10 ±20%, 1/2W	344135	75378	190PC100B	2	1	
R3	Res, var, cermet, 500 ±10%, 1/2W	291120	89536	291120	1	1	
R4	Res, var, cermet, 200 ±10%, 1/2W	285148	89536	285148	1	1	
R5, R7	Res, var, cermet, 50 ±10%, 1/2W	285122	89536	285122	2	1	
R6	Res, var, cermet, 20 ±20%, 1/2W	261180	75378	190PC200B	1	1	
R8	Res, var, cermet, 50k ±10%, 1/2W	288290	89536	288290	1	1	
R9, R14, R15, R16, U1	Ref Amp Set	415034	89536	415034	1	1	
R10	Res, mf, 3.4k ±1%, 1/8W	260323	91637	MFF1-83401F	1		
R11, R13	Res, mf, 12.1 ±1%, 1/8W	296608	91637	MFF1-812R1F	2		
R12	Res, mf, 24.3 ±1%, 1/8W	281816	91637	MFF1-824R3F	1		
R17, R18	Res, mf, 10k ±1%, 1/8W (T9)	328120	91637	MFF1-81002F	2		
R19, R21, R49	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	3		
R20, R28, R30	Res, mf, 10k ±1%, 1/8W (T0)	168260	91637	MFF1-81002F	3		
R22, R23	Res, Ref Inverter Set	409896	89536	409896	1		
R24	Res, comp, 470 ±5%, 1/4W	147983	01121	CB4715	1		
R25, R26	Res, mf, 49.9k ±1%, 1/8W	268821	91637	MFF1-84992F	2		
R27	Res, comp, 62 ±5%, 1/4W	261842	01121	CB6205	1		
R29, R60	Res, comp, 33k ±5%, 1/4W	148155	01121	CB3335	2		
R31	Res, mf, 11.3k ±1%, 1/8W	293639	91637	MFF1-81132F	1		
R32	Res, mf, 24.9k ±1%, 1/8W	291369	91637	MFF1-82492F	1		

CHECK ERRATA

CHANGE #13

A10A1 FAST R^2 A/D CONVERTER ANALOG ASSEMBLY (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R33, R37	Res, comp, 47 ±5%, 1/4W	147892	01121	CB4705	2		
R34, R35, R50 thru R54, R56	Res, Set	409946	89536	409946	1	1	
R36	Res, mf, 26.7k ±1%, 1/8W	245779	91637	MFF1-82672F	1		
R38, R39, R41	Res, mf, 75k ±1%, 1/8W	291443	91637	MFF1-87502F	3		
R40, R48	Res, comp, 15k ±5%, 1/4W	148114	01121	CB1535	2		
R42	Res, comp, 3k ±5%, 1/4W	193508	01121	CB3025	1		
R43	Res, comp, 510 ±5%, 1/4W	218032	01121	CB5115	1		
R44	Res, comp, 1.5k ±5%, 1/4W	148031	01121	CB1525	1		
R45	Res, comp, 470k ±5%, 1/4W	188441	01121	CB4745	1		
R46	Res, mf, 665 ±1%, 1/8W	320028	91637	MFF1-86650F	1		
R47	Res, mf, 1M ±1%, 1/8W	268797	91637	MFF1-81004F	1		
R55	Res, mf, 56.2 ±1%, 1/8W	305938	91637	MFF1-856R2F	1		
R58	Res, mf, 2573 ±0.1%, 1/8W	321463	91637	MFF1-82573F	1		
R61	Res, mf, 57.6k ±1%, 1/8W	289116	91637	MFF1-85762F	1		
R62	Res, mf, 66.5k ±1%, 1/8W	289082	91637	MFF1-86652F	1		
R63	Res, mf, 100k ±1%, 1/8W	248807	91637	MFF1-81003F	1		
R65	Res, comp, 820 ±5%, 1/4W	148015	01121	CB8215	1		
R66	Res, comp, 5.1k ±5%, 1/4W	193342	01121	CB5125	1		
R67	Res, mf, 18.7 ±1%, 1/8W	441776	91637	MFF1-812R7F	1		
R68	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	1		
U1, R9, R14, R15, R16	Ref Amp Set (See R9)	415034	89536	415034	REF		
U2, U3	IC, Op-Amp	271502	12040	LM301A	2	1	
U4, U7	IC, Op-Amp, J-FET, input	310037	12040	LH0042CH	2	1	
U5, U6	IC, lin, vol, follower	288365	12040	LM310H	2	1	
U8	IC, Op-Amp	225961	24355	AD3092	1	1	

A10A1 FAST R² A/D CONVERTER ANALOG ASSEMBLY (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U15	Res Network, 33k	413146	89536	413146	1	1	
U19	Res Network, 100k	380618	89536	380618	1	1	
1	Case Half	402990	89536	402990	1		
2	Case Half	402982	89536	402982	1		
3	Cover	402974	89536	402974	1		
4	Decal	413450	89536	413450	1		
5	Guard, front	383315	89536	383315	1		
6	Guard, rear	383364	89536	383364	1		
7	Shield, cover	411967	89536	411967	1		
8	Spacer	152207	07047	10123DAP	1		

CHECK ERRATA

CHANGE #10,32

A10A2 FAST R² A/D CONVERTER DIGITAL ASSEMBLY

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A10A2 Ⓧ	**FAST R² A/D CONVERTER DIGITAL ASSEMBLY (MIS-1741)** Figure 5-11	383760	89536	383760	REF		
C1	Cap, Ta, 220 uF ±20%, 6V	408682	56289	196D227X0006TE4	2		
C2, C3	Cap, mica, 82 pF ±5%, 500V	148502	72136	DM15F820J	2		
J1, J2	Cable Assy, 16 pin conn	380576	08261	5122-003.5	2		
Q1	Xstr, Si, PNP	226290	04713	MPS3640	1		
R1	Res, comp, 47k ±5%, 1/4W	148163	01121	CB4735	1		
R2, R3	Res, comp, 20k ±5%, 1/4W	221614	01121	CB2035	2		
R4	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R5, R6	Res, mf, 100k ±1%, 1/8W	248807	91637	MFF1-81003F	2		
R7	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	1		
U1, U2, U6, U11, U12, U22, U32, U34, U35	Ⓧ IC, C-MOS, dual type "D" flip-flop	340117	02735	CD4013AE	9	2	
U3, U7, U21	Ⓧ IC, Dgtl, C-MOS, hex inverter	404681	02735	CD4069BE	3	1	
U4, U13, U37	Res Network	380618	89536	380618	3	1	
U5	Ⓧ IC, Dgtl, COS-MOS, dual, complementray pair	408013	02735	CD4007AE	1	1	
U8, U36	Ⓧ IC, Dgtl, C-MOS, quad, 2-input NAND gates	355198	02735	CD4011AE	2	1	
U14, U15, U17, U23, U38	IC, Linear, 5-xstr array	380188	02735	CA3183E	5	1	
U16, U26	Ⓧ IC, Dgtl, C-MOS, quad, 2-input OR gate	408393	02735	CD4071BE	2	1	
U25	Ⓧ IC, Dgtl, C-MOS, quad, 2-input, AND gate	408401	02735	CD4081BE	1	1	
U31	Ⓧ IC, Dgtl, C-MOS, divide by –8, counter/ divider	403360	02735	CD4022AE	1	1	
U33	Ⓧ IC, Dgtl, C-MOS, quad, 2-input NAND gates	375147	02735	CD4023AE	1	1	

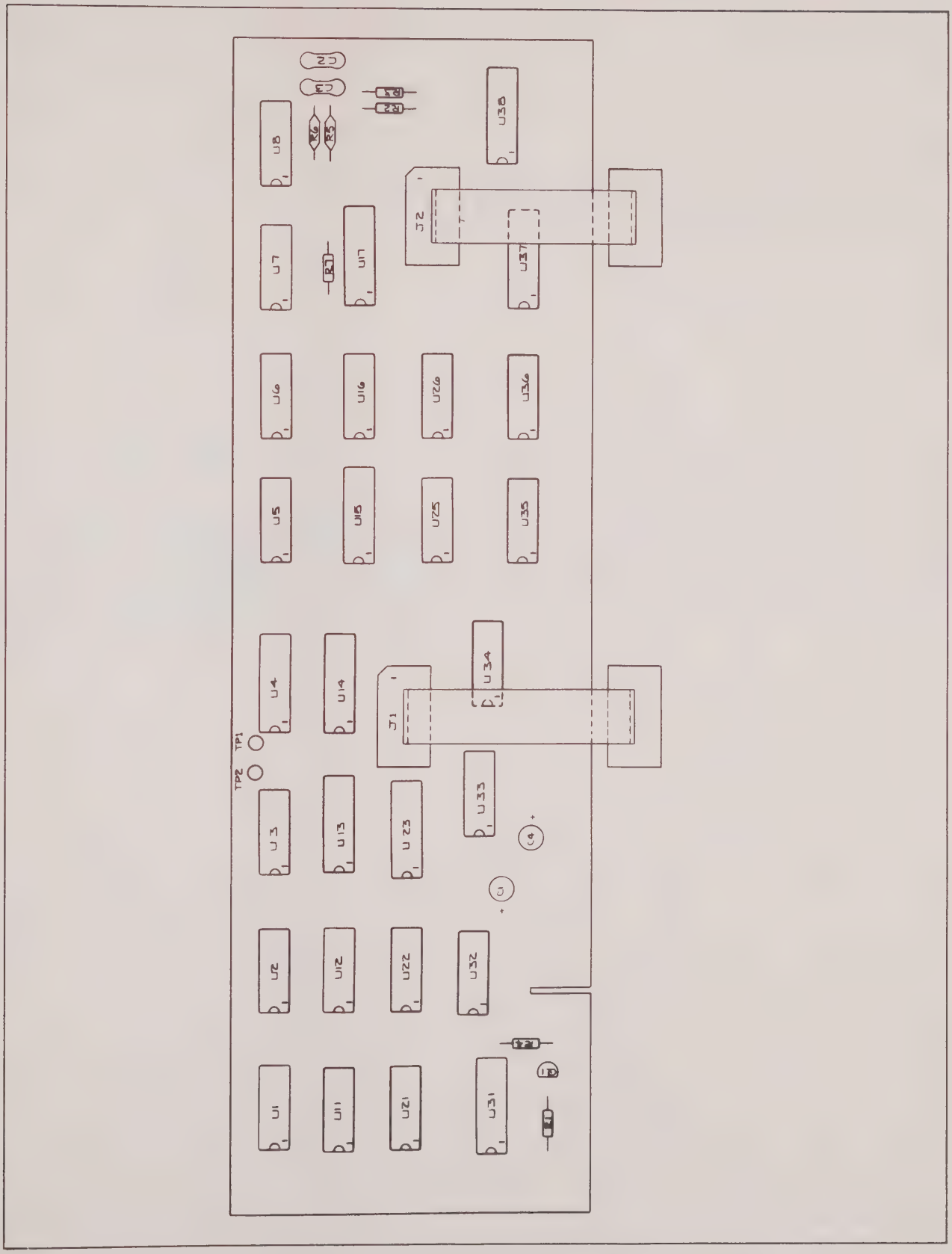


Figure 5-11. A10A2, Fast R² A/D Converter (Digital)

Section 6
Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual employs modular construction. Information relating to accessories for the 8500A is included first. Page and paragraph numbering for accessories is a 600-X series where X is the page or paragraph number. Optional modules ordered with your instrument will be covered in modular subsections included in your manual. Page and paragraph numbering is a 6YY-X series where YY is the option number (–01, –02, –17, etc.) and X is the page or paragraph number.

6-3. As you expand your 8500A system, manual subsections covering the option you order will be included with the option. This assures the most up-to-date information. Additional subsections can easily be added to this section.

TABLE OF CONTENTS

OPTION/ MODEL NO.	DESCRIPTION	DOCUMENTATION SUPPLIED:	PAGE NO.
	ACCESSORIES		
M04-205-600	Rack Ear Mounting Assembly	Herein	600-1
80F-5	High Voltage Probe	Herein	600-1
80F-15	High Voltage Probe	Herein	600-2
81RF	High Frequency Probe	Herein	600-2
82RF	High Frequency Probe	Herein	600-2
KDM1	Keyboard Display Module	Herein	600-2
	OPTIONS		
–01	AC/DC Converter (Averaging)	With Option	601-1
–02	Ohms Converter	With Option	602-1
–03	Current Shunts	With Option	603-1
–04	Calibration Memory	With Option	604-1
–05	IEEE Standard 488-1975 Interface	With Option	605-1
–06	Bit Serial Asynchronous Interface	With Option	606-1
–07	Parallel Interface	With Option	607-1
–08	Isolator	With Option	608-1
–09	AC/DC Converter (RMS)	With Option	609-1
–17	Rear Input	With Option	617-1

Accessories

600-1. RACK EAR MOUNTING ASSEMBLY

600-2. Figure 600-1 illustrates installation of the Rack Ear Mounting Assembly. Use the following procedure.

1. Remove the nameplate decals from handles.
2. Remove the screws from handles.
3. Attach rack ears with # 8 - 32 x 5/8 PHP screws (enclosed in kit).
4. Remove the front screws from top and bottom cover which match the hole pattern in trim items.
5. Attach trim angle on top cover and trim channel on bottom cover with # 6 - 32 x 3/8 PHP screws and lock washer (enclosed in kit).

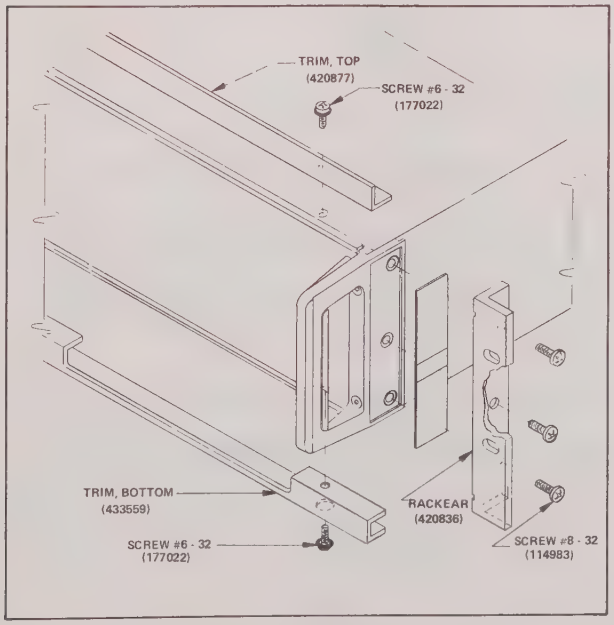


Figure 600-1. Rack Ear Mounting Installation

600-3. HIGH VOLTAGE PROBE (80F-5)

600-4. The Model 80F-5 Voltage Divider shown in Figure 600-2 allows measurement of up to 5k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

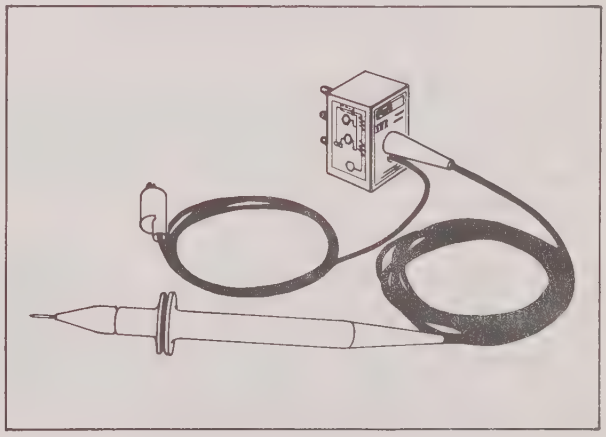


Figure 600-2. 80F5 Voltage Divider

600-5. Physical design of the Model 80F-5 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

600-6. Three versions of the Model 80F-5 are available. The basic Model 80F-5 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided

for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohms or greater) at null.

600-7. HIGH VOLTAGE PROBE (80F-15)

600-8. The Accessory Model 80F-15 Voltage Divider, shown in Figure 6-7, allows measurement of up to 15k volts dc to be made using FLUKE 800, 900, and 8000 series voltmeters. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors having matched temperature coefficients.

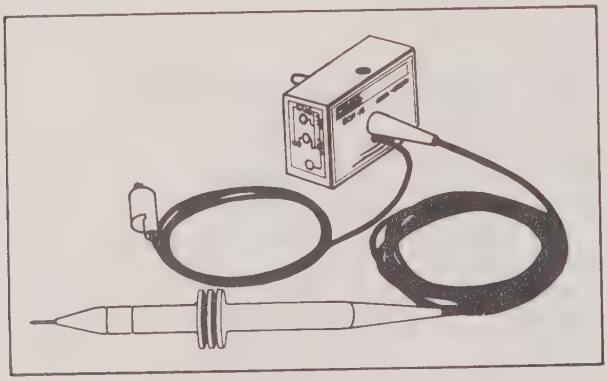


Figure 600-3. 80F15 Voltage Divider

600-9. Physical design of the Model 80F-15 allows direct mating to the input terminals of the FLUKE voltmeters. A high voltage probe facilitates connection to the measurement source. Maintenance is minimized by encapsulation of the divider components.

600-10. Three versions of the Model 80F-15 are available. The basic Model 80F-15 is used with voltmeters having a 10 megohm input resistance. An (01) Option is provided for voltmeters having an 11 megohm input resistance, and an (02) Option is provided for voltmeters having an infinite input resistance (10^3 megohm or greater) at null.

600-11. HIGH FREQUENCY PROBE (81 RF)

600-12. The Model 81RF High Frequency Probe, Figure 600-4, extends the frequency range of the DVM/DMM to include 100 kHz to 100 MHz for ac voltage measurements from 0.25 to 30V rms. The 81RF operates in conjunction with the dc voltage ranges, and is connected to the DVM DMM using a shielded dual-banana plug and, when necessary, a dual banana adaptor.

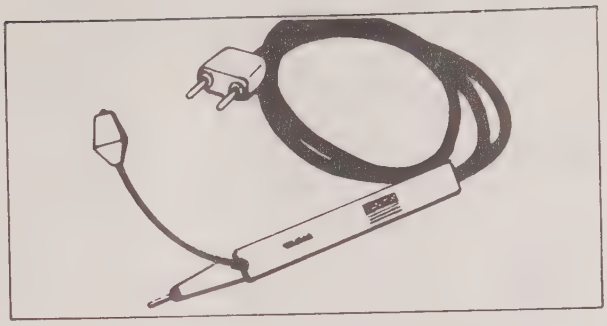


Figure 600-4. 81RF High Frequency Probe

600-13. HIGH FREQUENCY PROBE (82RF)

600-14. The Model 82RF High Frequency Probe, Figure 600-5, allows measurements over a frequency range of 100 kHz to 500 MHz from 0.25 to 30V rms. It is designed to be used with voltmeters having an input impedance of 10 megohms + 10%. It may be used with a voltmeter having an input impedance higher than 10 megohms provided the input is externally shunted to make the equivalent input impedance equal to 10 megohms.

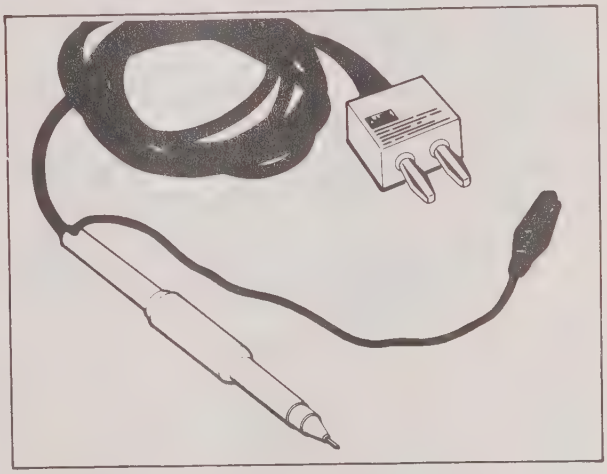


Figure 600-5. 82RF High Frequency Probe

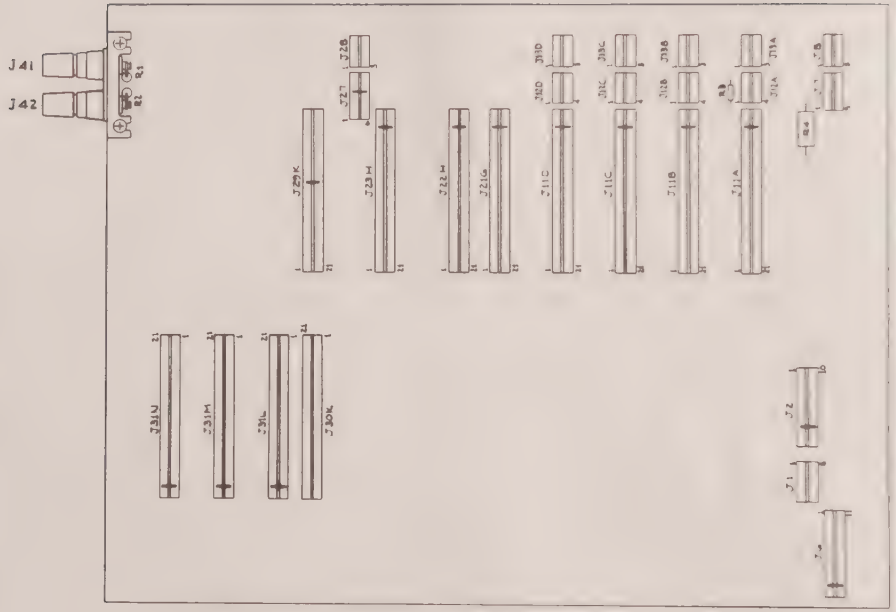
600-15. Circuitry within the 82RF consists of a capacitor-coupled rectifier circuit which responds to the peak value of the input waveform. The output is positive polarity dc which is calibrated to be equivalent to the rms value of a sine wave.

600-16. KEYBOARD DISPLAY MODULE (KDM1)

600-17. The Micon KDM1 Keyboard Display Module is a LED display terminal (with a connecting cable) for use with the Bit Serial Asynchronous Interface (Option –06). Standard ASCII characters are used on the keyboard to facilitate programming the 8500A.

Section 8
Schematic Diagrams

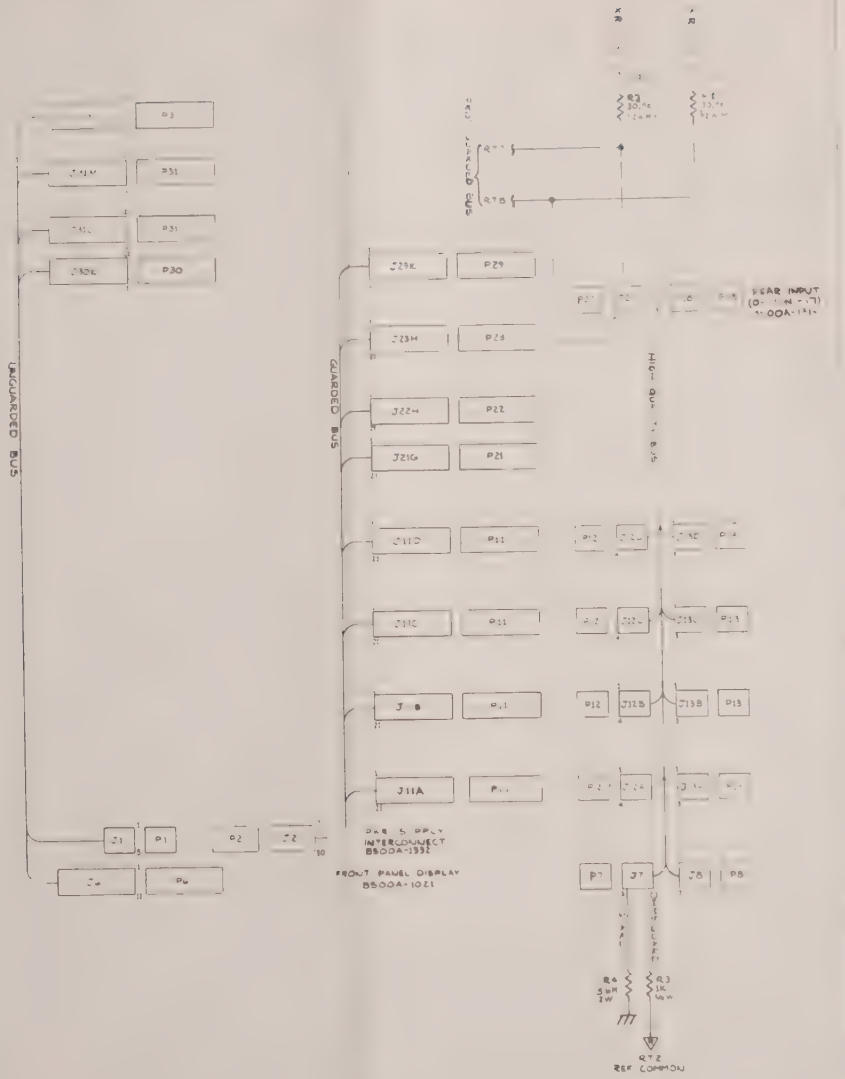
FIGURE NO.	NAME	DRAWING NO.	PAGE
8-1	Reference Designation, Motherboard PCB Assembly	8500A-1601	8-3
8-2	Interconnect Diagram (2 Sheets)	8500A-1301	8-4
8-3	Mother Board Interconnect	8500A-1001	8-6
8-4	Bus Interconnect	M.I.S.-1081	8-7
8-5	Reference Designation, Power Supply	8500A-1631	8-8
8-6	Power Supply	8500A-1041	8-9
8-7	Power Supply Interconnect	8500A-1332	8-10
8-8	Reference Designation, Controller	M.I.S.-1785	8-11
8-9	Controller (2 Sheets)	M.I.S.-1185	8-12
8-10	Reference Designation, Front Panel Display Assembly	8500A-1621	8-14
8-1	Front Panel	8500A-1021-D	8-15
8-12	Reference Designation, D.C. Signal Cond. Assembly	M.I.S.-1700	8-16
8-13	M.I.S. D.C. Signal Conditioner	M.I.S.-1100-D	8-17
8-14	Reference Designation, Active PCB Assembly	M.I.S.-1730	8-18
8-15	Active Filter/External Reference	M.I.S.-1130	8-19
8-16	Reference Designation, Fast R^2 A/D Converter (Digital)	M.I.S.-1741	8-20
8-17	Reference Designation, Fast R^2 A/D Converter (Analog)	M.I.S.-1740	8-21
8-18	Fast R^2 A/D (Digital)	M.I.S.-1141	8-22
8-19	Fast R^2 A/D (Analog)	M.I.S.-1140	8-23



NOTES:

1. FOR ASSY DRAWING SEE 8500A-4001
2. FOR PCB SEE 8500A-3001
3. FOR SCHEMATIC SEE 8500A-1001
4. FOR INTERCONNECT DIAGRAM SEE 8500A-1301

Figure 8-1. Reference Designation, Motherboard PCB Assembly (8500A-1601)



NOTES:
1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1601
2. FOR REF DES. DRAWING SEE M.I.S.-1601
3. FOR ASSY DRAWING SEE M.I.S.-4001

Figure 8-2. Interconnect Diagram (8500A-1301)

(Sheet 1 of 2)

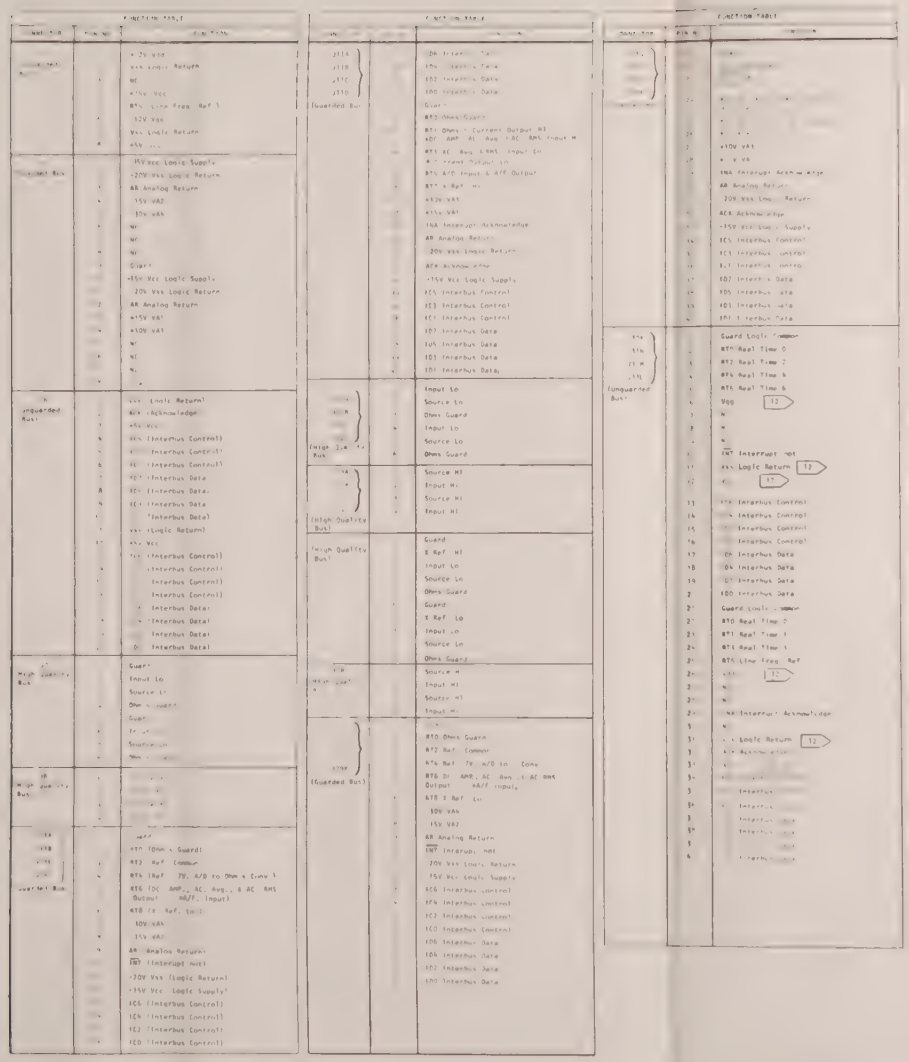


Figure 8-2. Interconnect Diagram (8500A-1301)

(Sheet 2 of 2)

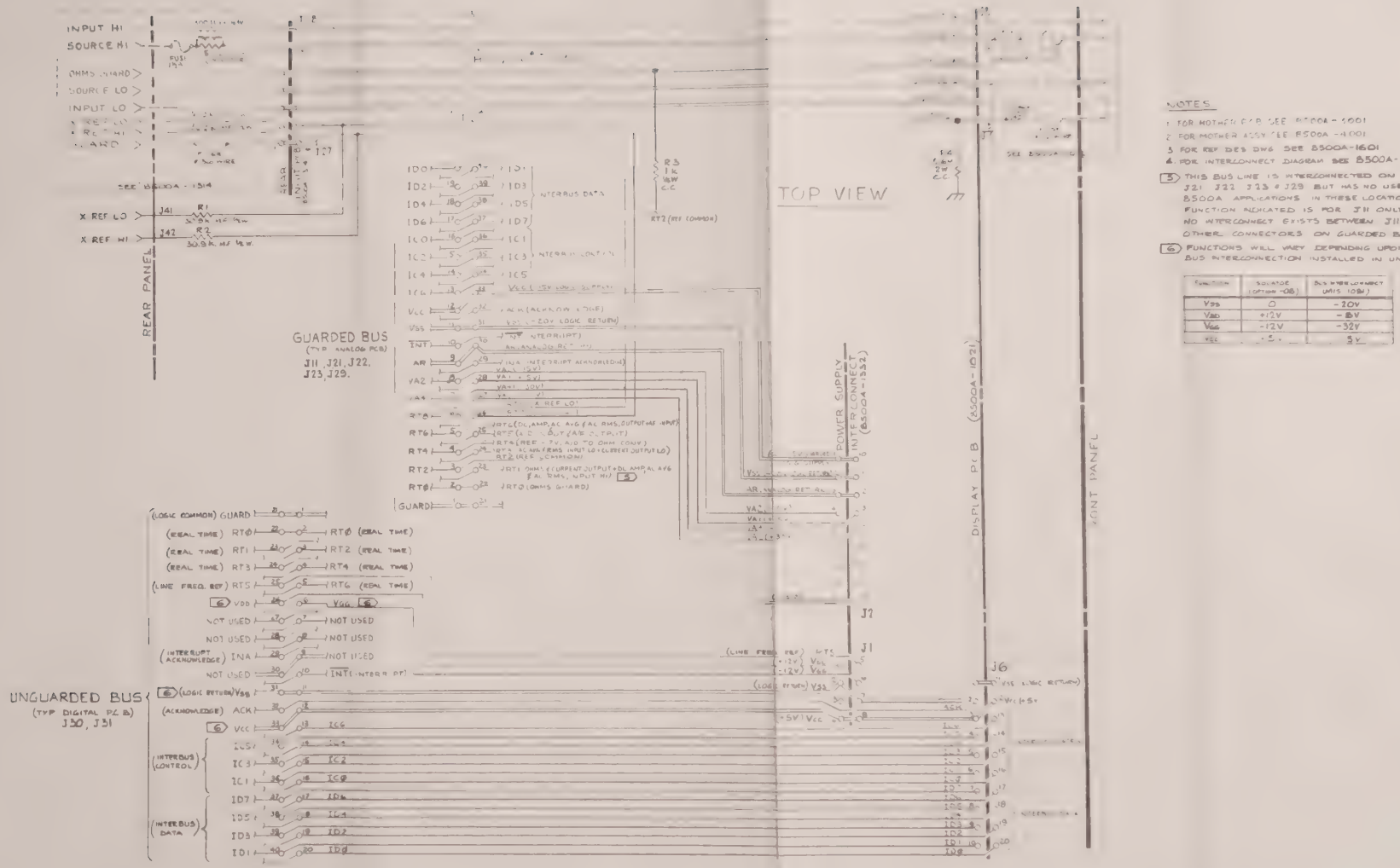
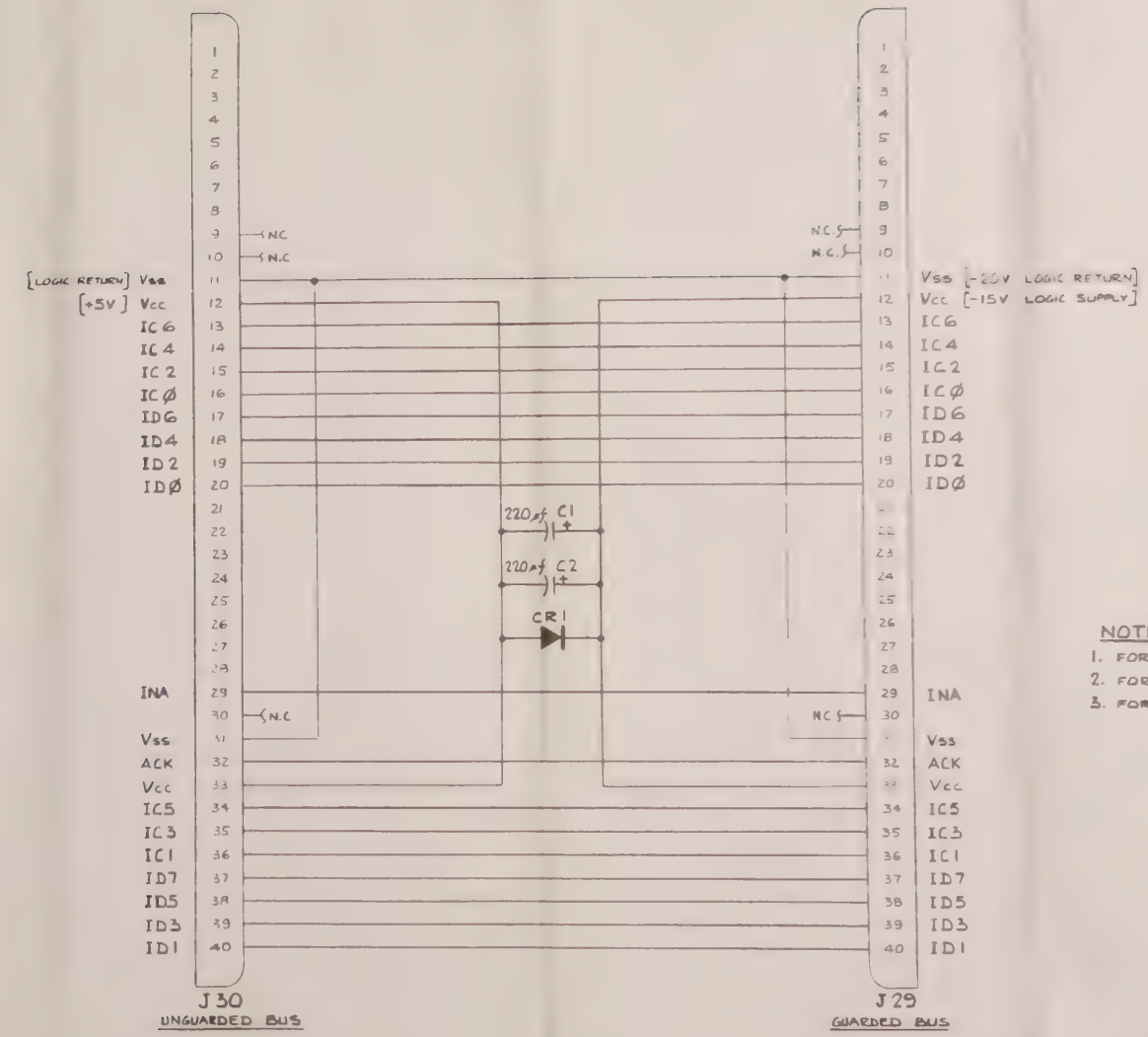


Figure 8-3. Mother Board Interconnect (8500A-1001)

NOTES

1. FOR MOTHER P/B SEE 8500A-1001
2. FOR MOTHER ASSY SEE 8500A-1001
3. FOR REF DES DWG SEE 8500A-1601
4. FOR INTERCONNECT DIAGRAM SEE 8500A-1301
5. THIS BUS LINE IS INTERCONNECTED ON J21 J22 J23 & J29 BUT HAS NO USE ON 8500A APPLICATIONS. IN THESE LOCATIONS. FUNCTION INDICATED IS FOR J11 ONLY. NO INTERCONNECT EXISTS BETWEEN J11, PIN 23 & OTHER CONNECTORS ON GUARDED BUS.
6. FUNCTIONS WILL VARY DEPENDING UPON BUS INTERCONNECTION INSTALLED IN UNIT

FUNCTION	ISOLATOR (OPTION -08)	BUS INTERCONNECT (MIS 1084)
V_{SS}	0	-20V
V_{DD}	+12V	-8V
V_{GG}	-12V	-32V
V_{CC}	+5V	5V

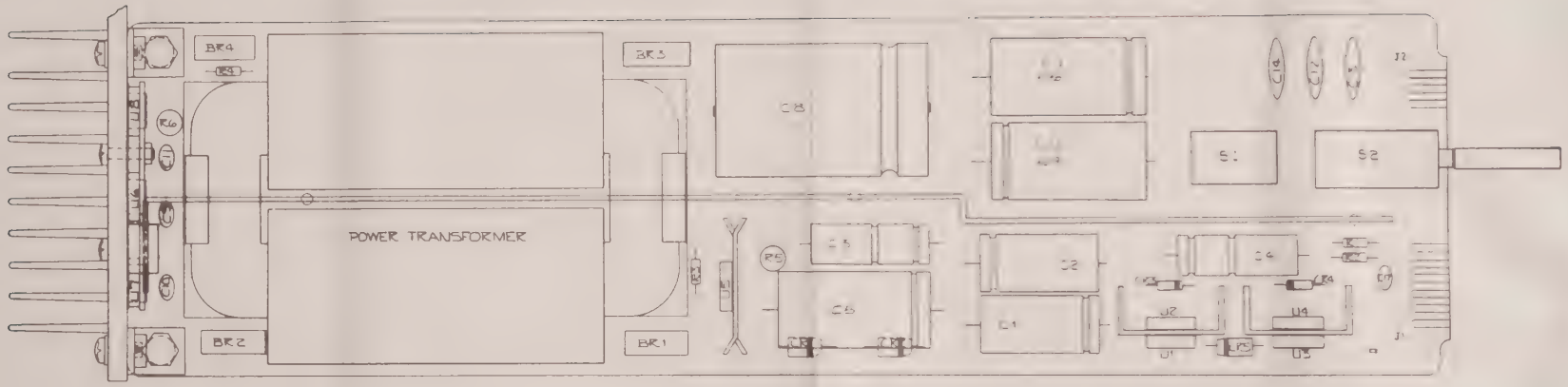


NOTES:

1. FOR P.C.B. SEE M.I.S.-3081
2. FOR ASSY SEE M.I.S.-4081
3. FOR REF. DES. SEE M.I.S.-1681

Figure 8-4. Bus Interconnect (M.I.S.-1081)

CHANGE #26



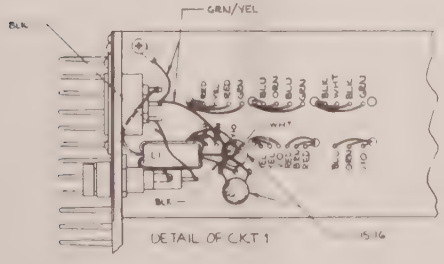


Figure 8-5. Reference Designation, Power Supply

(8500A-1631)

CHANGE #2

NOTES (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTANCE IN OHMS
2. ALL RESISTORS C.C. ¼W, 5%
3. ALL CAPACITANCE IN MICROFARADS
4. FOR ASSY DRG SEE 8500A-4041
5. FOR REF DES DRG SEE 8500A-1641
6. FOR P.C.B. SEE 8500A-3041

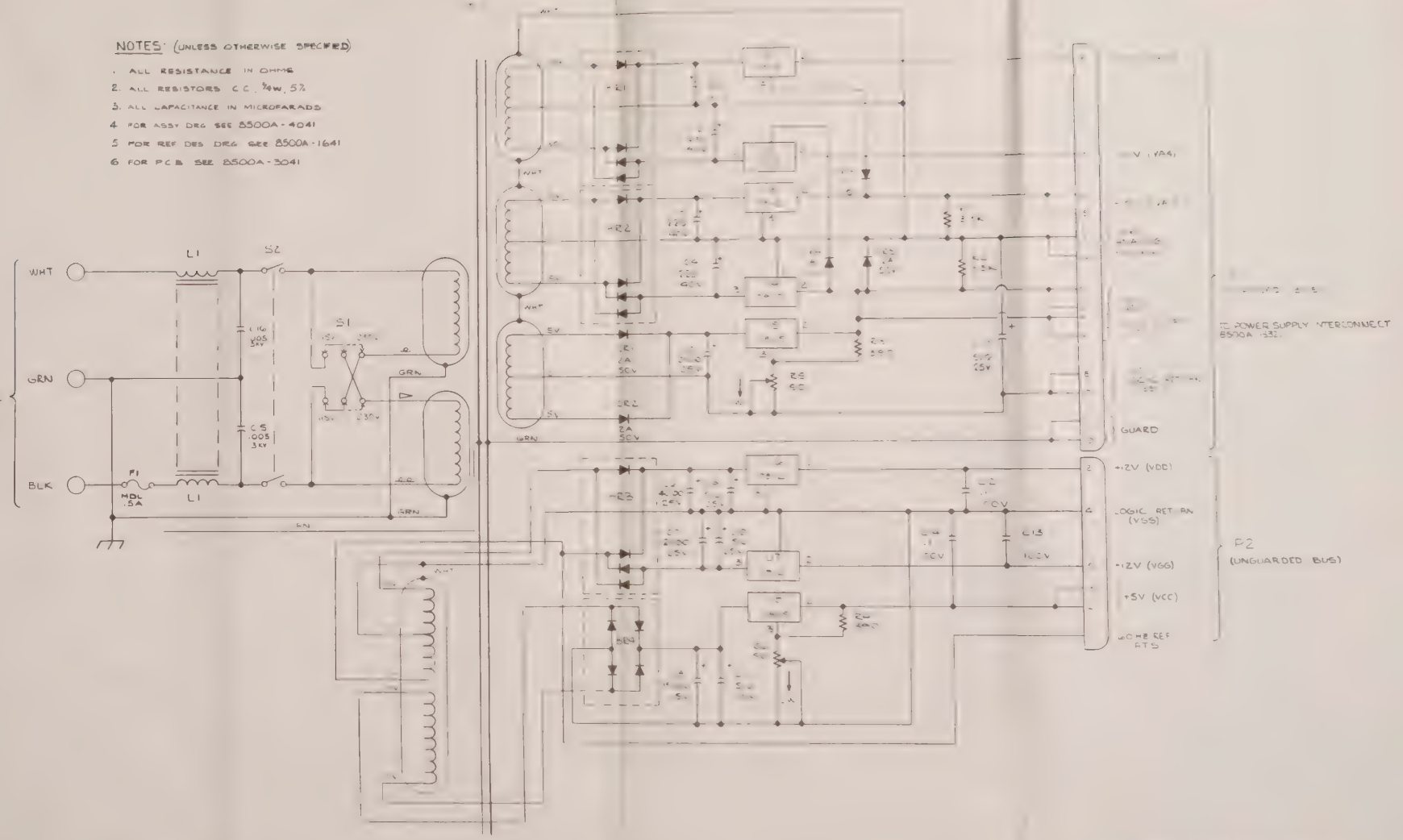


Figure 8-6. Power Supply (8500A-1041)

NOTES:

1. FOR P.C.B. SEE 8500A-3032
2. FOR ASSY. SEE 8500A-4032
3. FOR PWR SUPPLY SCHEMATIC SEE 8500A-1041
4. FOR MOTHER INTERCONNECT DIAGRAM SEE 8500A-1301

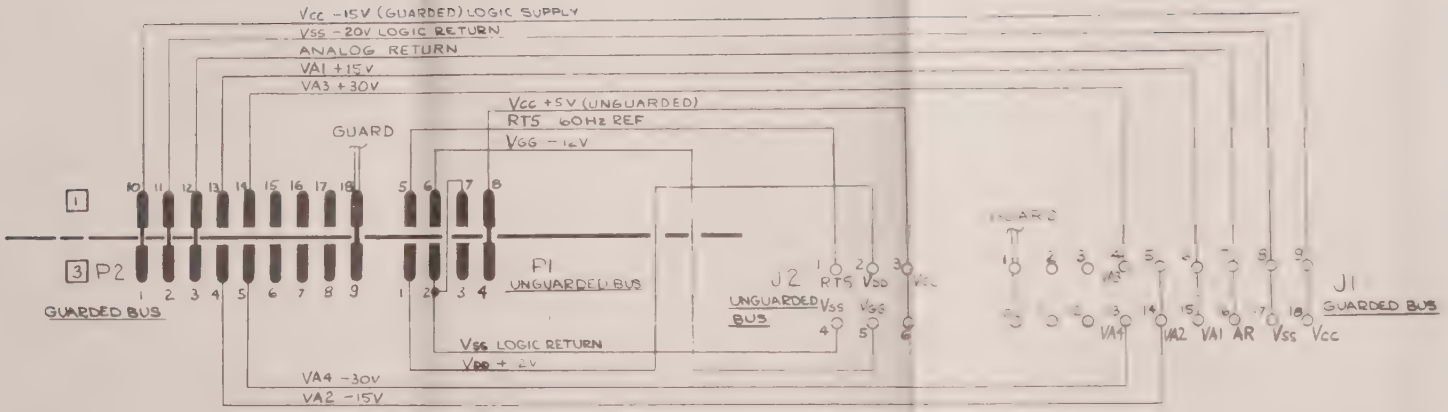


Figure 8-7. Power Supply Interconnect (8500A-1332)

CHANGE #19

ACK		acknowledge
ACK LAT	–	acknowledge late
AR	–	analog return
DB	–	data bus
DBIN	–	data bus input signal (from μP)
DLD ACK	–	delayed ACK
EN INT	–	enable interrupt
HLDA	–	hold acknowledge
IB ADX	–	interbus address
IBIN	–	interbus input signal
IC		interbus control
ID		interbus data
IINT		internal interrupt
INA		interrupt acknowledge (from controller)
INT	–	interrupt
INTA	–	Interrupt acknowledge (status word from μP)
INTE	–	interrupt enable (from μP)
MEM RD	–	memory read
MS ADDR BYTE	–	memory select address byte
ϕ1	–	clock pulse
ϕ2	–	clock pulse
ϕLL	–	phase-locked loop
RAM	–	random access memory
ROM	–	read only memory
RRDY	–	reset ready
RST	–	reset
RT	–	real time
R/W	–	read/write
μP	–	microprocessor
VA	–	analog supply voltage
V_{CC} ϕ2	–	5V clock pulse
V_{DD} ϕ2	–	12V clock pulse
SRDY	–	set ready
SYN IINT	–	synchronized internal interrupt
TTL PU	–	TTL pull-up
WO	–	write out
WR		write

NOTES:
1. FOR ASSEMBLY DWG SEE MIS-4185
2. FOR PCB SEE MIS-2185
3. FOR SCHEMATIC SEE MIS-1185

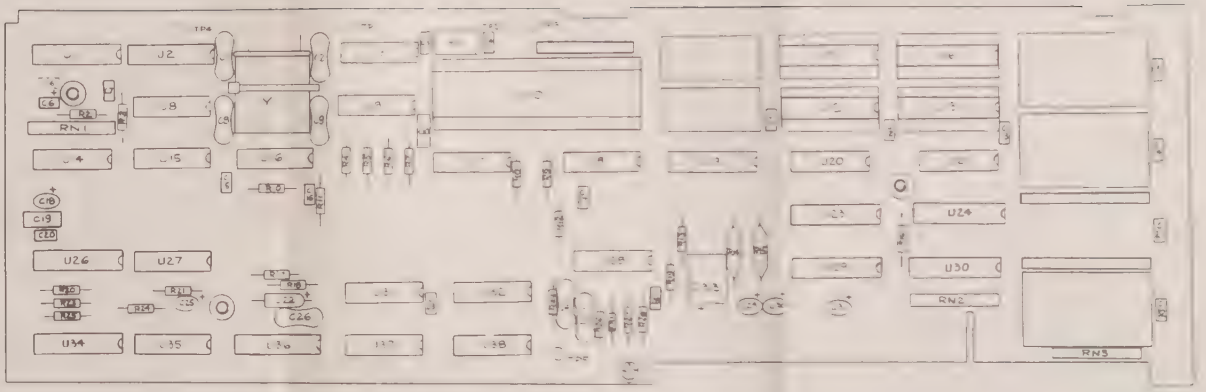


Figure 8-8. Reference Designation Controller (M.I.S.-1785)

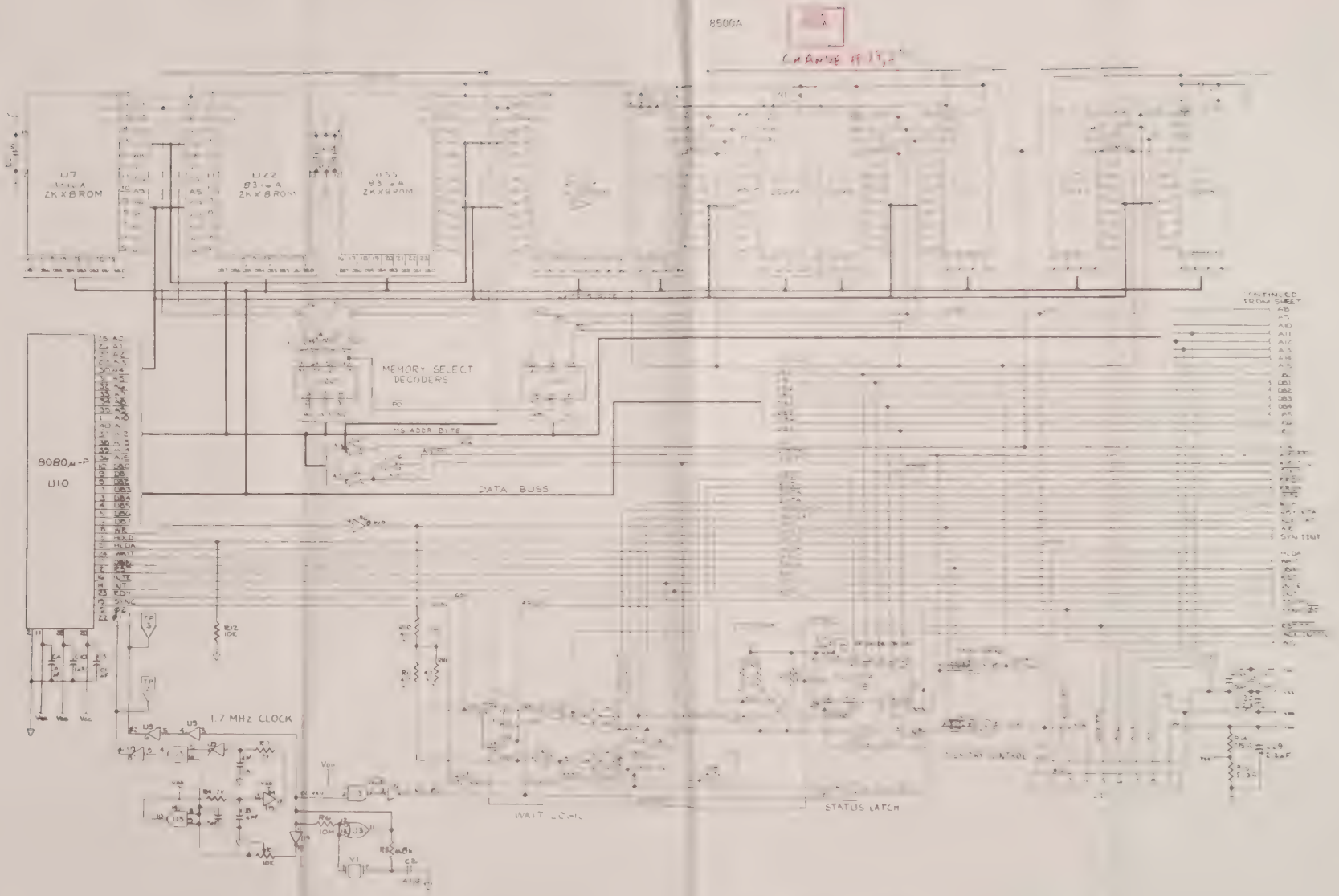


Figure 8-9. Controller (M.I.S.-1185) (Sheet 1 of 2)

Change #2, 19, 30

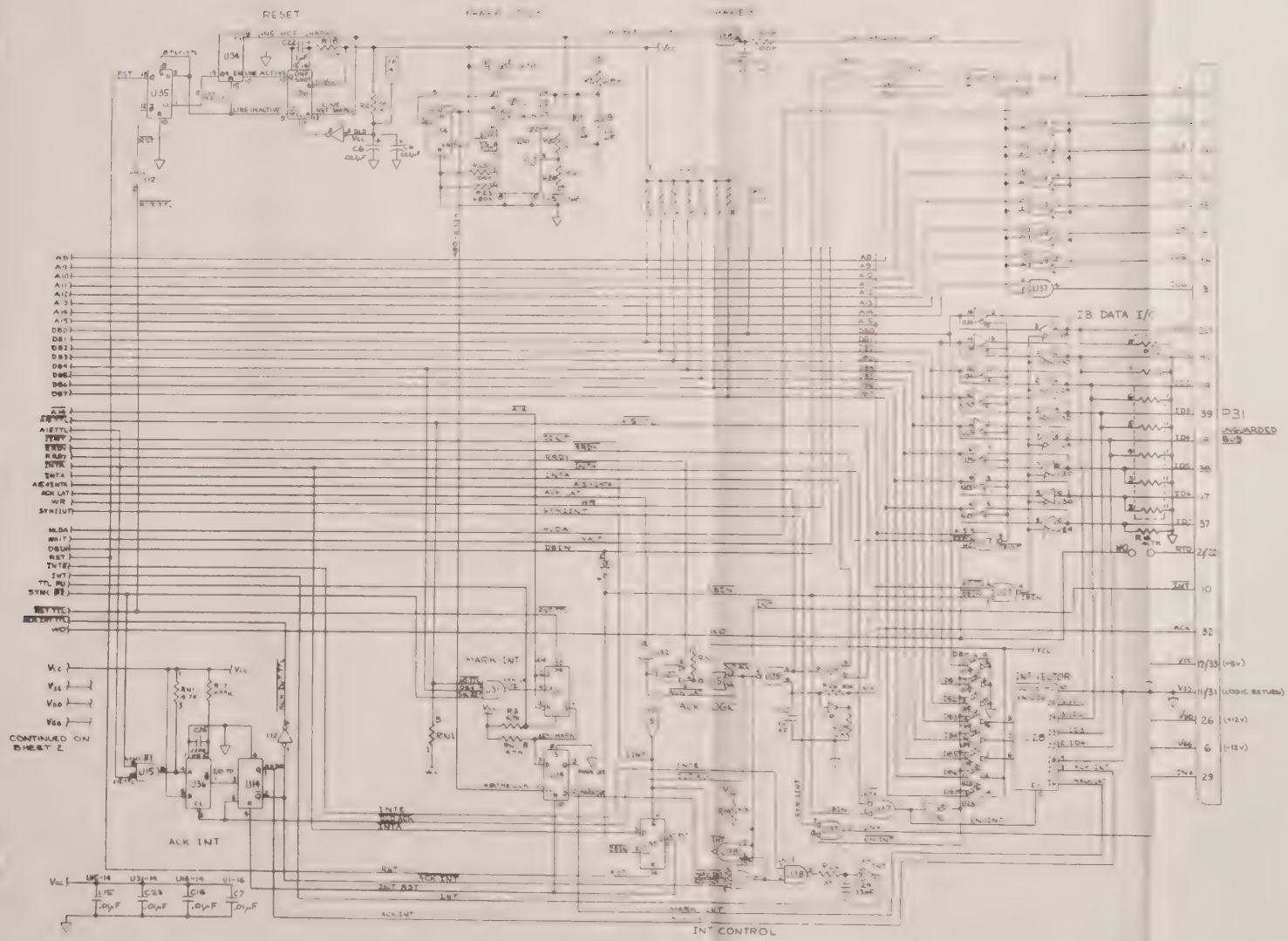


Figure 8-9. Controller (M.I.S.-1185) (Sheet 2 of 2)

NOTES:
1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1121
2. FOR P.C.B. SEE M.I.S.-3021
3. FOR ASSEMBLY SEE M.I.S.-4021

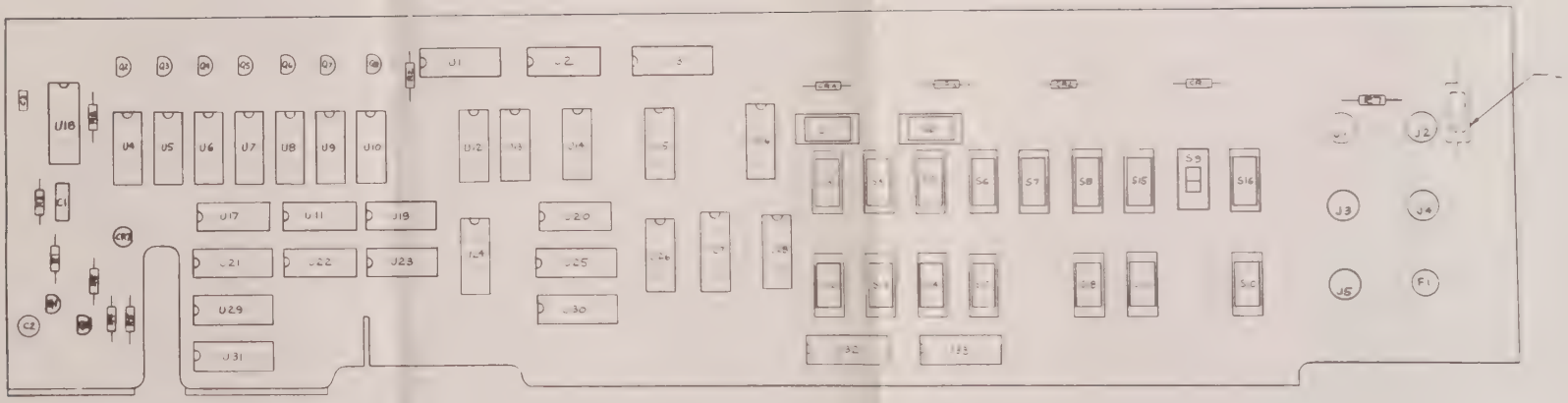


Figure 8-10. Reference Designation,
Front Panel Display Assembly (8500A-1621)

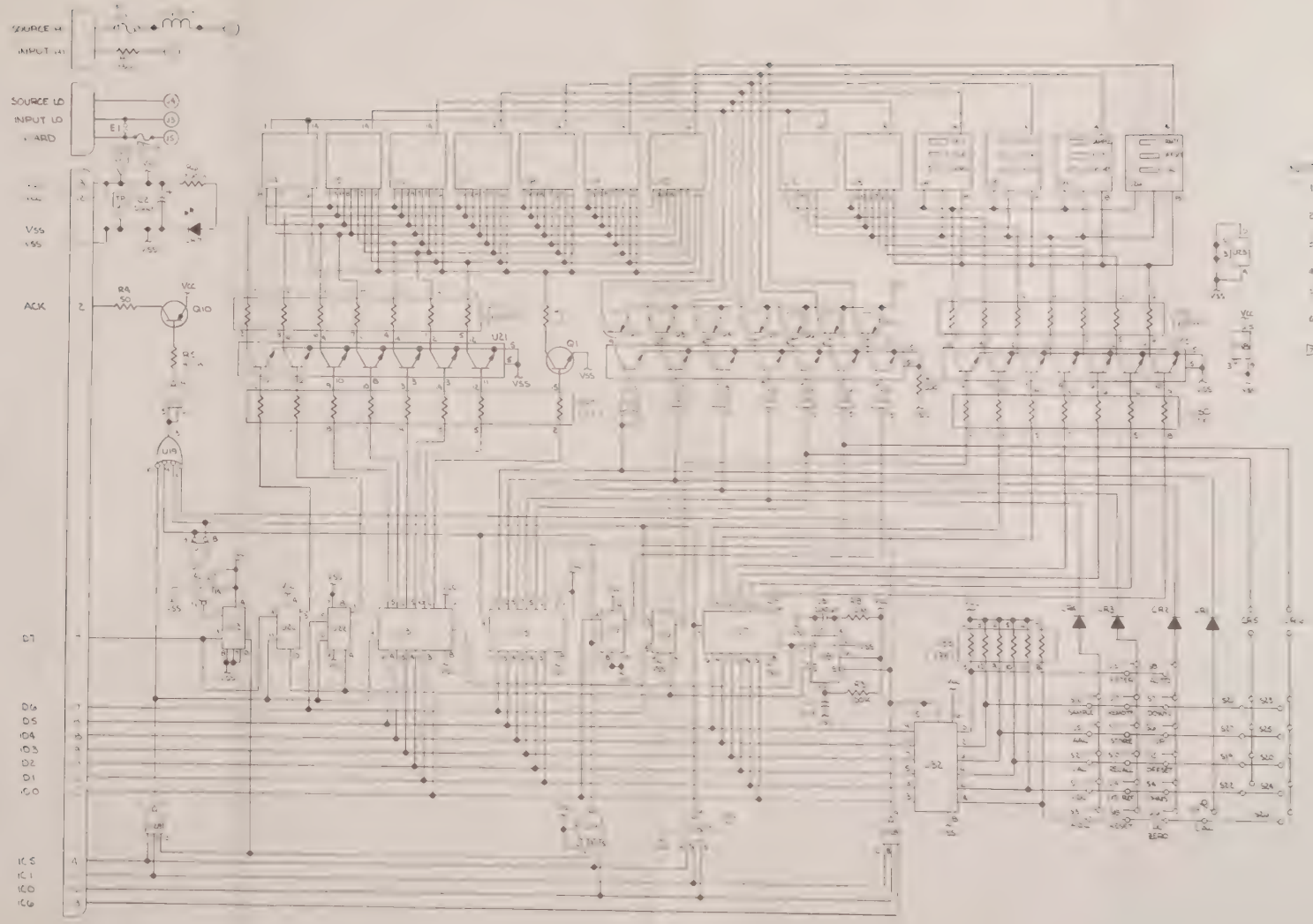


Figure 8-11. Front Panel (8500A-1021-D)

ERRATA

CHANGE #2

NOTES:

1. FOR SCHEMATIC DIAGRAM SEE M.S.-1100
2. FOR P C B SEE M.I.S - 3100
3. FOR ASSY DRG. SEE M.I.S - 4100
4. R54, R55, R56 & R57 WILL BE DETERMINED DURING TESTING. RESISTORS MAY BE INSTALLED

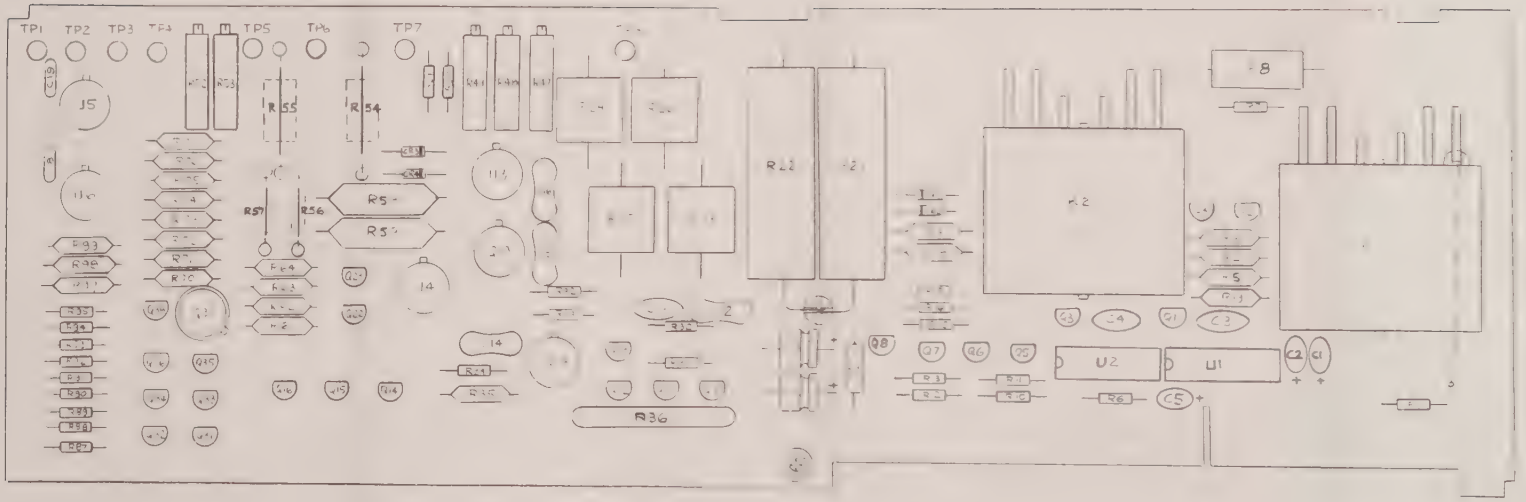


Figure 8-12. Reference Designation,

D.C. Signal Cond. Assembly (M.I.S.-1700)

CHANGE #22

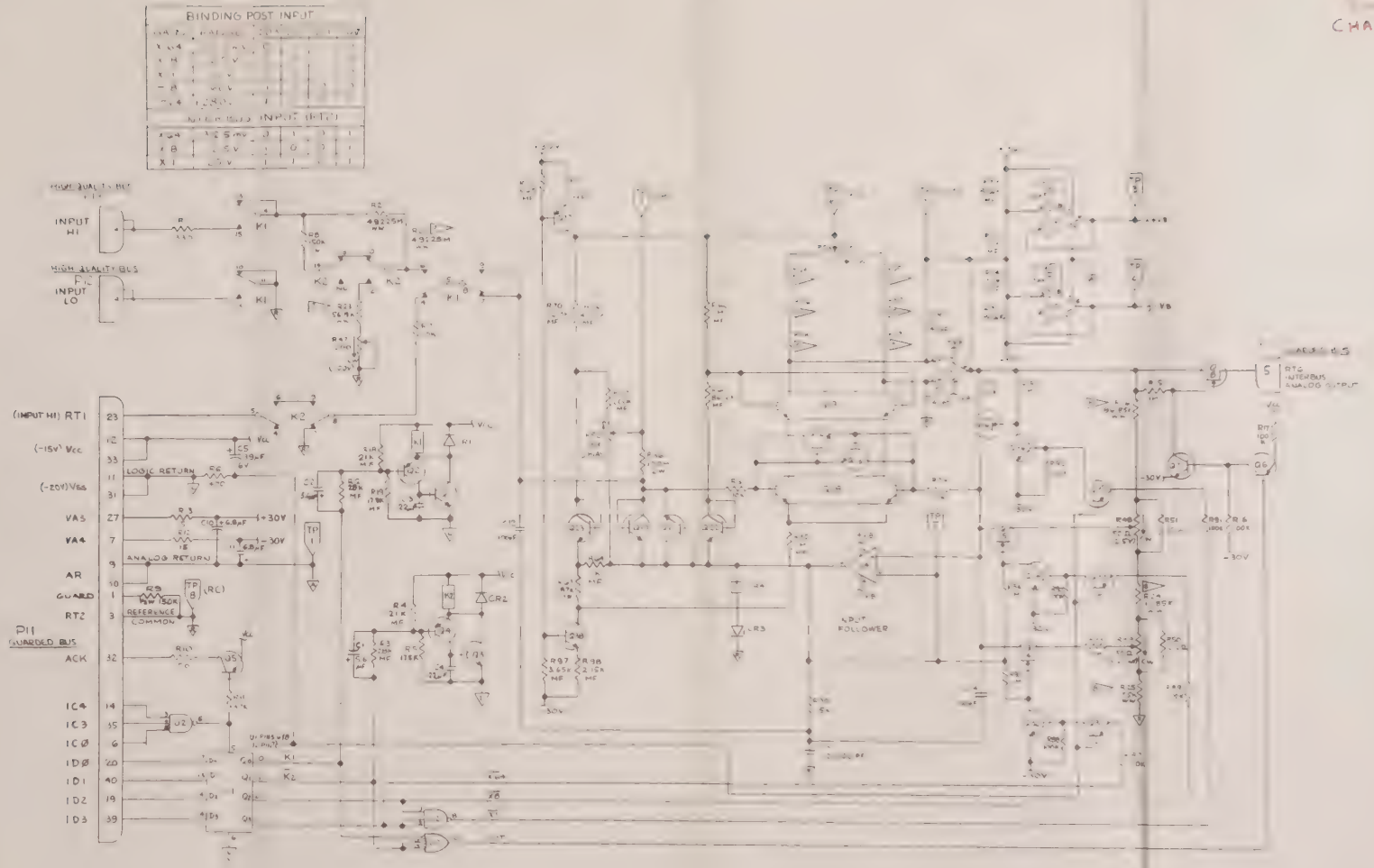
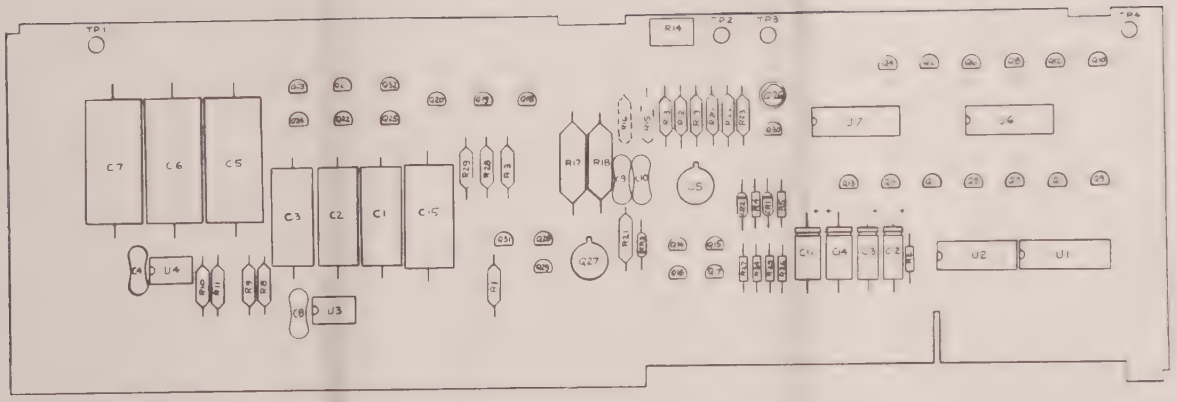


Figure 8-13. M.I.S. D.C. Signal Conditioner (M.I.S.-1100)



NOTES:

1 FOR SCHEMATIC DIAGRAM SEE MIS-1130
2 FOR PCB SEE MIS-3130
3 FOR ASSEMBLY SEE MIS-4130.
4 R15 & R16 WILL BE SELECTED DURING TEST

Figure 8-14. Reference Designation,
Active Filter PCB Assembly (M.I.S.-1730)

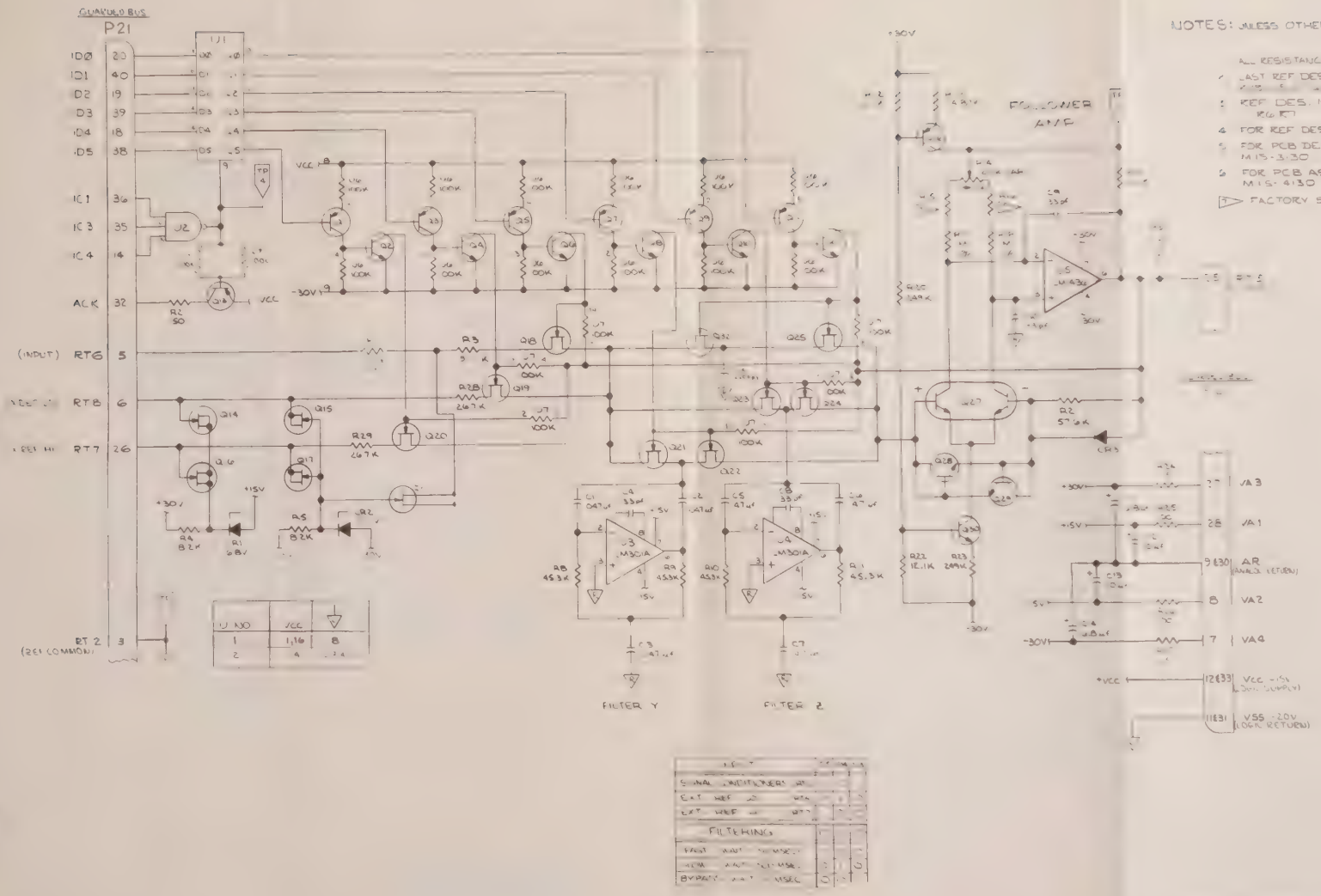


Figure 8-15. Active Filter/External Reference (M.I.S.-1130)

NOTES:

1 FOR SCHEMATIC SEE M.I.S.-1141
2 FOR PCB DETAIL SEE M.I.S.-3141
3 FOR ASSY DRAWING SEE M.I.S.-4141

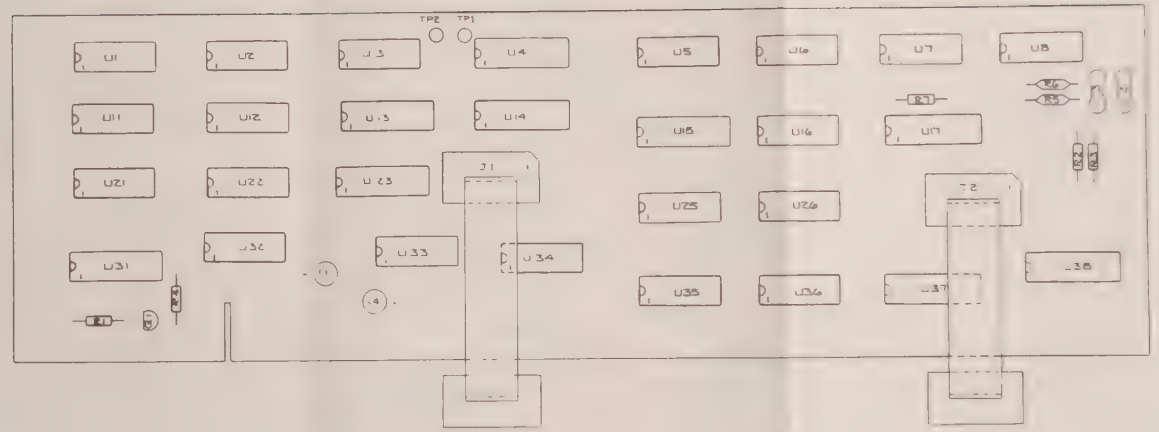


Figure 8-16. Reference Designation,
Fast R² A/D Converter (Digital) (M.I.S.-1741)

NOTES:

1. FOR SCHEMATIC DIAGRAM SEE M.I.S.-1140.
2. FOR P.C.B. SEE M.I.S.-3140
4. FOR ASSEMBLY DRAWING SEE M.I.S.-4140

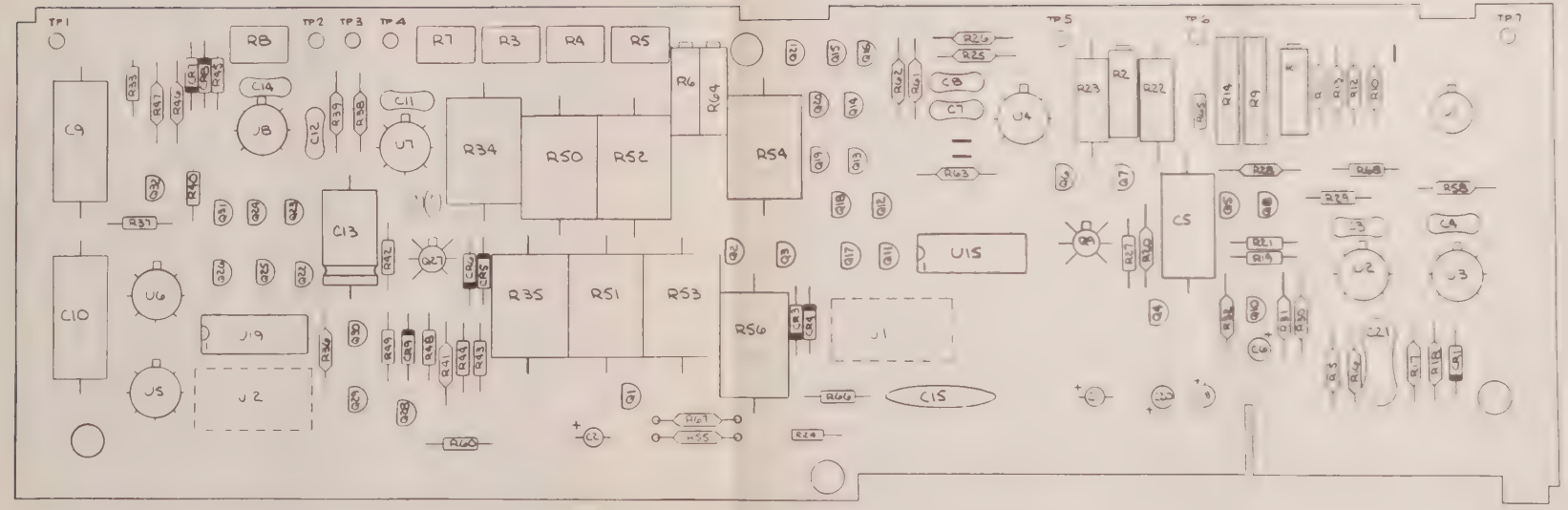


Figure 8-17. Reference Designation,
Fast R² A/D Converter (Analog) (M.I.S.-1740)

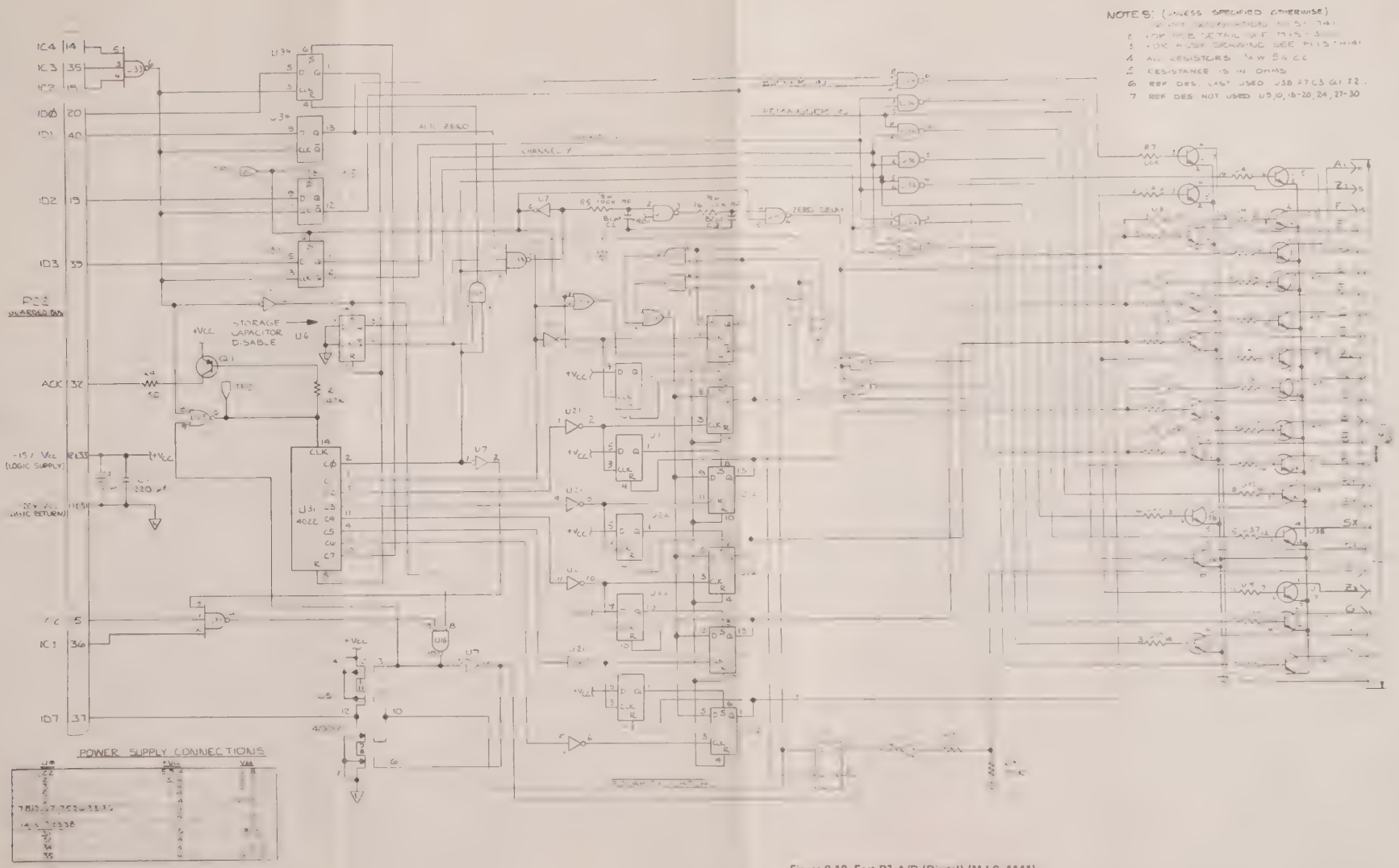

NOTES: (UNLESS SPECIFIED OTHERWISE)
1 INTEGRATED CIRCUIT DESIGNATIONS ARE SN54/74
2 FOR PCB DETAIL SEE M.I.S.-1141
3 FOR ASSY DRAWING SEE M.I.S.-1141
4 ALL RESISTORS 1/4 W 5% CC
5 RESISTANCE IS IN OHMS
6 REF DES. LAST USED U38 R73 C3 Q1 T2
7 REF DES NOT USED U9,10,18-20,24,27-30
POWER SUPPLY CONNECTIONS
STORAGE CAPACITOR DISABLE
ZERO DELAY
CHANNEL Y
ALL ZERO

Figure 8-18. Fast R² A/D (Digital) (M.I.S.-1141)

CHANGE #12, 31

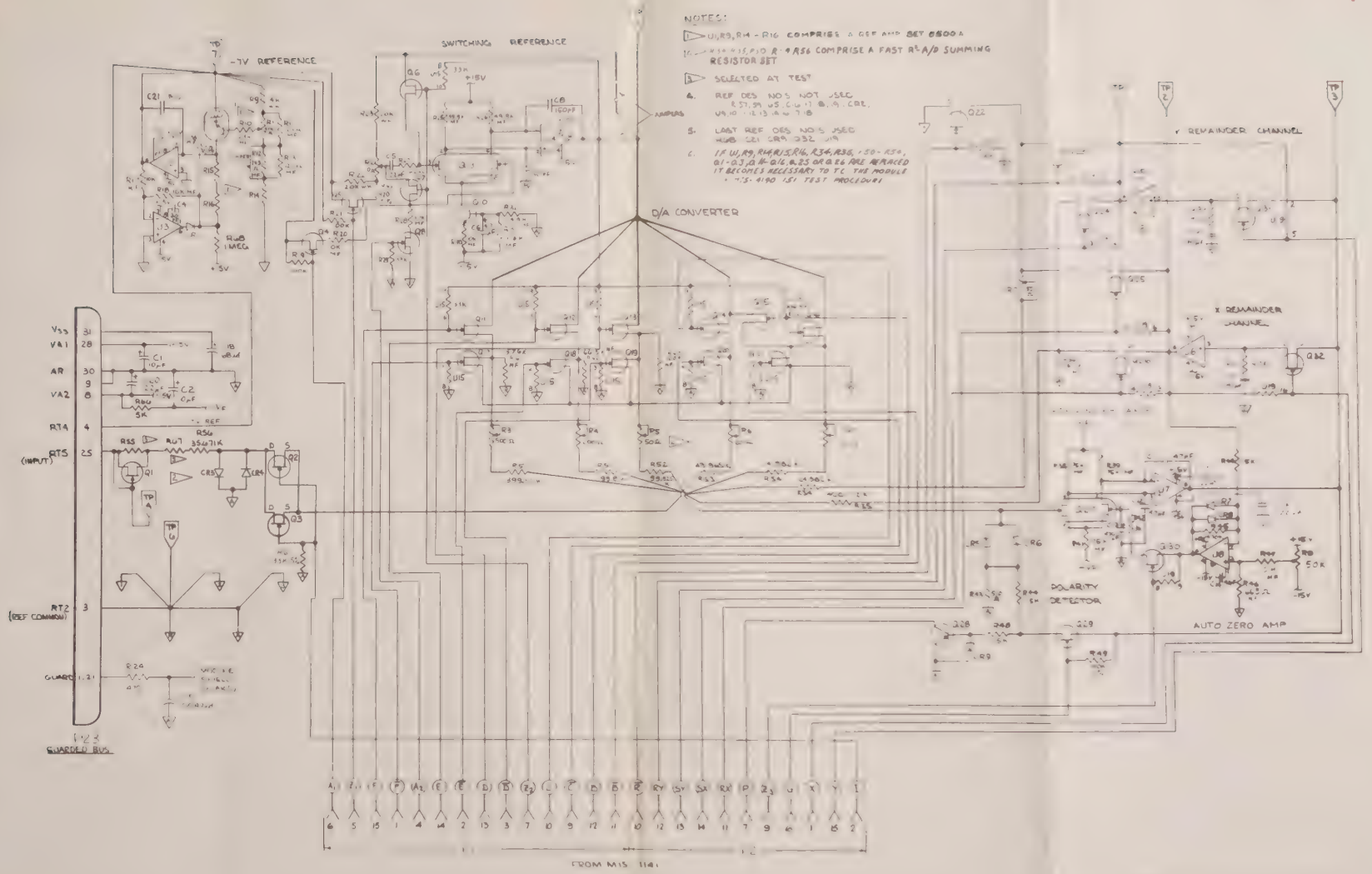

NOTES:
1. U1, R9, R14 - R16 COMPRISES A REF AMP SET 8500A
2. R33, R35, R10 & R56 COMPRISE A FAST R² A/D SUMMING RESISTOR SET
3. SELECTED AT TEST
4. REF DES NOS NOT USED: R57, 59, 65, C41, C43, C81, C89, CR2, U9, 10, 12, 13, 14 & T18
5. LAST REF DES NOS USED: W28, C21, CR9, J32, U19
6. IF U1, R9, R14, R15, R16, R34, R36, R50-R54, Q1-Q3, Q6 & Q16, 8, 25 OR Q 8, 25 ARE REPLACED IT BECOMES NECESSARY TO T.C. THE MODULE * "T.S. 4190 1S1 TEST PROCEDURE
-7V REFERENCE
SWITCHING REFERENCE
D/A CONVERTER
Y REMAINDER CHANNEL
X REMAINDER CHANNEL
AUTO ZERO AMP
POLARITY DETECTOR
+ REF
- REF
RT1
RT2 (REF COMMON)
RT3 (INPUT)
GUARD
GUARDED BUS
FROM M1S 1141

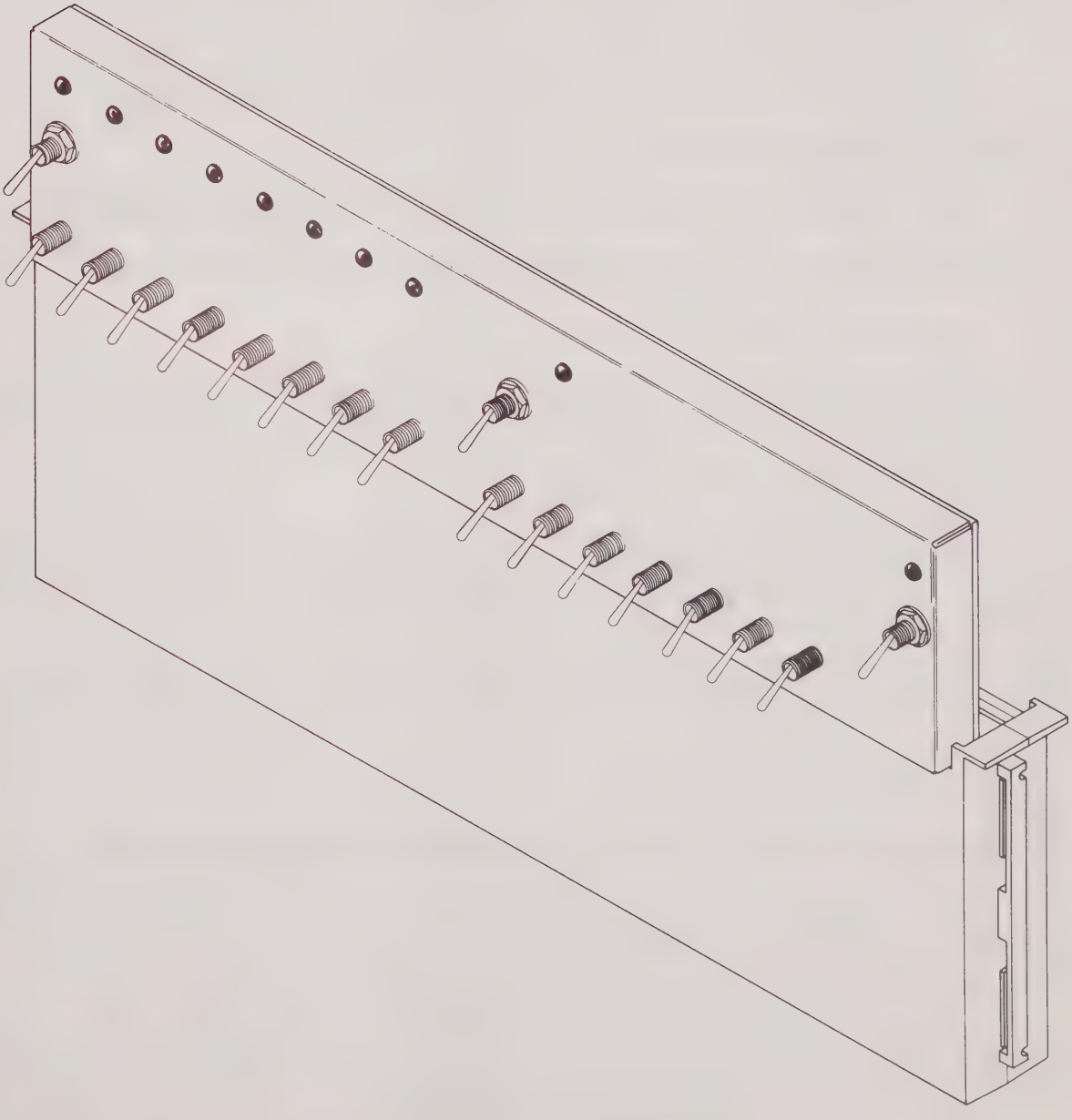
Figure 8-19. Fast R² A/D (Analog) (M.I.S.-1140)

FLUKE®

Operator's Manual

Model MIS-7190K

Static Controller



P/N 487140 2/78

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In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within one year of the original purchase, provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within one year of the original purchase, said repairs or replacement will be made without charge. If the fault has been caused by misuse, neglect, accident or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

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2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

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CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

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Rev. 12/77

Introduction

This manual offers both general descriptive and usage information for the Static Controller module and specific procedures for troubleshooting other modules.

The Static Controller module can simulate a number of functions performed by the Controller used in the 8500 series Digital Multimeters and the 5100 series Calibrators. Using the interbus structure of either instrument, the Static Controller can address and command other modules. For digital modules, returned data will be displayed on the Static Controller. For analog modules, output levels can be checked against known inputs.

The Static Controller is designed, but not necessarily restricted, to testing with a minimum of other modules on the instrument's interbus. Advantages over normal troubleshooting techniques include:

1. Isolation from other modules; problems encountered are quite likely to be unique to the module under test.

2. In digital modules, logic states can be checked in one configuration at a time.

3. With analog modules, a stable signal can be maintained for more detailed troubleshooting within the module.

4. Linearity, accuracy and stability can be more accurately determined in analog modules.

If problem module isolation is the initial concern, it is recommended that the technician consult procedures given in Section 4 of the respective instrument's instruction manual. Alternately, techniques given in this manual for individual modules may be combined to check interbus operations and analog signal flow with the normal configuration of modules in the instrument.

Before an individual module is determined faulty, a check of another module's function may be useful in confirming interbus and power supply operation.

Accuracy and stability specifications can be found in either Section 1 (for standard modules) or Section 6 (for optional modules) of the tested instrument's instruction manual.

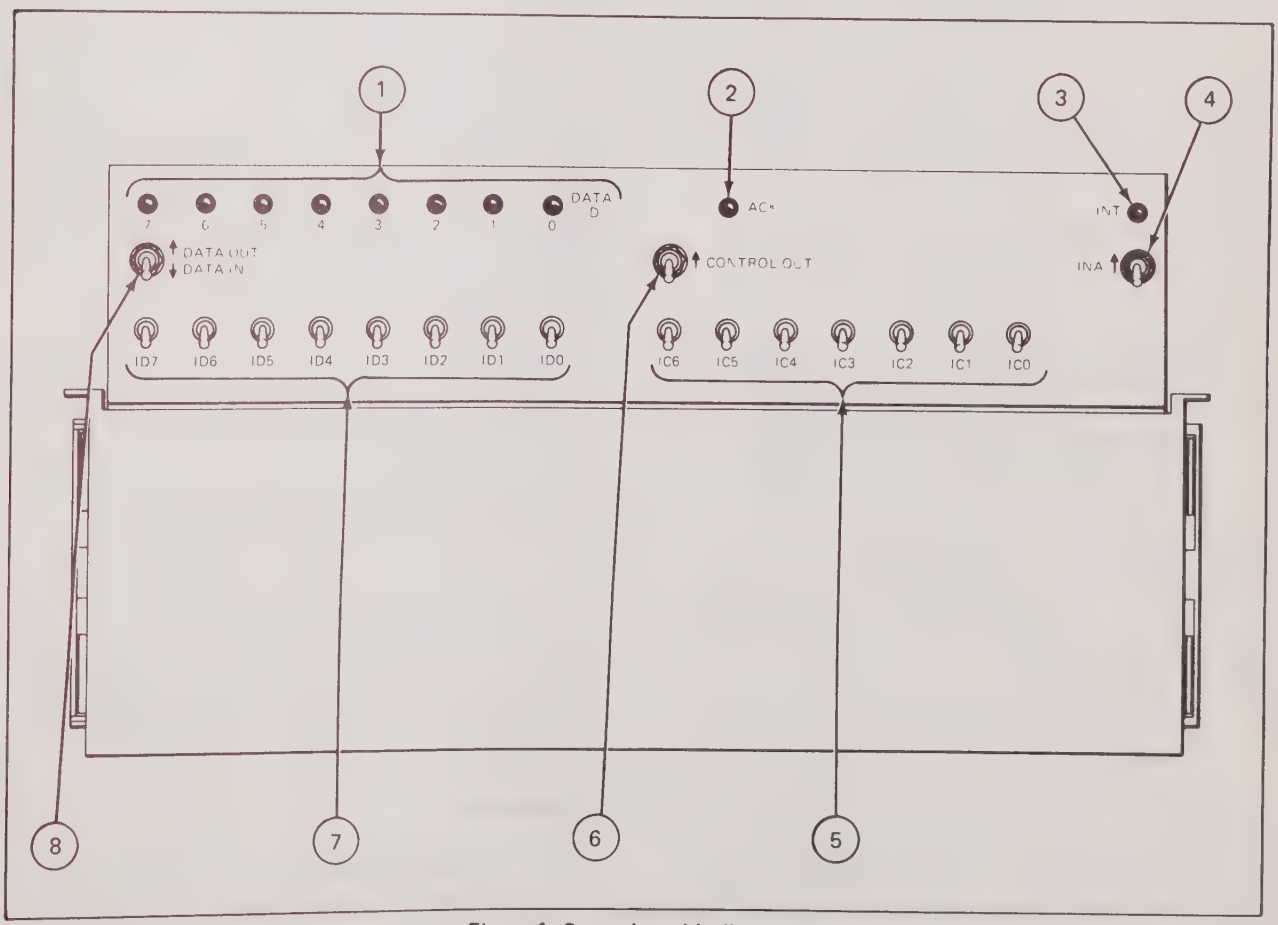


Figure 1. Controls and Indicators

Table 1. Controls and Indicators

REF. DES.	NAME	DESCRIPTION
1	DATA LED'S	Display logic levels source to or received from data (ID) lines. High = LED on.
2	ACKNOWLEDGE LED	Lights when an addressed module inputs an acknowledge signal to the Static Controller.
3	INTERRUPT LED	Lights when module generates an interrupt on the interbus.
4	INTERRUPT ACKNOWLEDGE	Toggled up when INT lights. ACK then lights and interrupt condition read on data LED's.
5	ADDRESS SWITCHES	Control logic levels on address (IC) lines. High = toggled up.
6	CONTROL OUT SWITCH	Gates IC bits onto address lines.
7	DATA SWITCHES	Control logic levels on data lines of the interbus.
8	DATA OUT SWITCH	Controls the direction of data on ID lines and source of levels shown in data LED's. In up position, ID switches control data LED's and output to the interbus. In down position, ID switches are inhibited from interbus; data LED's display information received from other modules.

Module Testing with the Static Controller

WARNING

THESE INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THESE INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

Static Discharge Precautions ⊗

The modules and assemblies to be tested with the Static Controller contain static sensitive components. Observe the following procedures:

1. Never install or remove modules without first turning the instrument's power switch to OFF.
2. Perform all repairs at a static-free work station.
3. Minimize handling of pcb's and modules; in no case handle them by their connectors.
4. Keep repair parts in their original containers until ready for use.
5. Use static ground straps to discharge repair personnel.
6. Use conductive foam or anti-static containers to store replacement or removed IC's and pcb's.
7. Remove all plastic, vinyl and styrafoam products from the work area.
8. Do not slide static sensitive devices over any surface.
9. Use only anti-static type solder removal tools.
10. Use grounded tip soldering irons.

NOTE

When using the Static Controller with the 8500 series DMM or the 5100 series calibrator, there will be no display or control from the front panel. Terminals will remain active.

STATIC CONTROLLER USE (GENERAL)

Instrument Bus Structure

UNGUARDED (DIGITAL) BUS

The unguarded digital interbus consists of seven control/address (IC) lines, eight bidirectional data (ID) lines, seven real time (RT) lines, three handshake (INT-interrupt, ACK-acknowledge, INA-interrupt acknowledge) lines, and power supply lines.

GUARDED (ANALOG) BUS

A guarded bus connects the controller to the analog modules through an interconnect pcb or through an optional isolator module (must replace the interconnect pcb if an optional remote interface is installed). The guarded bus consists of seven control/address (IC) lines, eight bidirectional data (ID) lines, nine real time (RT) lines, one handshake (ACK) line, and power supply lines.

The address, handshake and data lines of the two buses serve the same functions. The RT lines in the unguarded bus are unused except for RT5, which is the line frequency reference. The RT lines in the guarded bus form an analog bus which carries all the conditioned and converted analog signals between the analog modules.

Installation

In the 8500 series DMM, the Static Controller is designed to fit into either the guarded analog bus (Slot A, B, C, or

D) or the unguarded digital bus (Slot L, M, or N). Install the Bus Interconnect or Bus Interconnect and Monitor Card (Slot K) if the module being checked and the Static Controller are on different buses. The Static Controller will face backwards when placed in the guarded analog bus. See Figure 2 and Table 2 for slot locations.

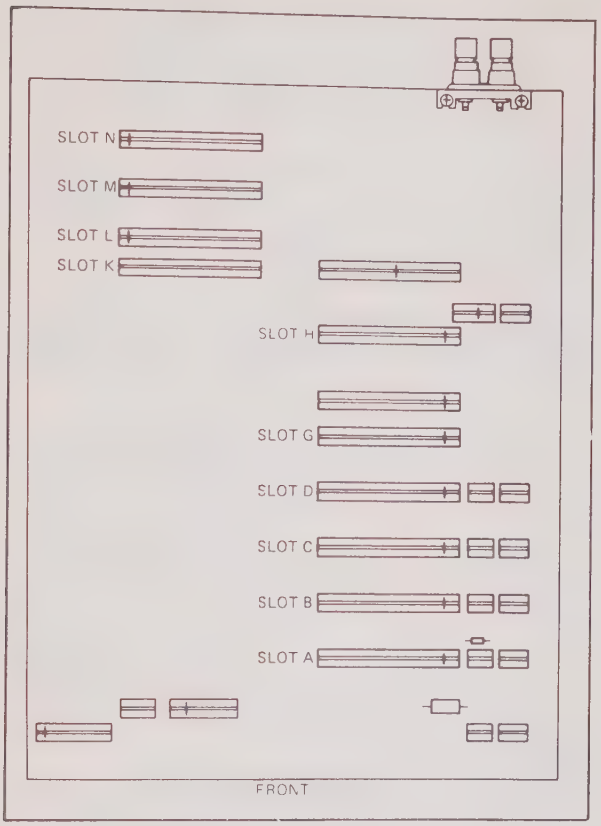


Figure 2. Module Installation Locations

In the 5100 series calibrator, the Static Controller will fit into any slot in the digital (rear) compartment.

STATIC CONTROLLER USE (8500 SERIES)

Using the Static Controller, address (IC), data (ID), and handshake information can be applied to analog buses. RT lines can be monitored to check analog signals. Returned data can be displayed on the Static Controller's ID LED's. Refer to Table 3 for specific RT line uses.

Module Installation and Removal

Use the following procedure when changing modules in the 8500 series DMM:

1. Turn power off, disconnect power line cord.
2. Remove top cover (6 phillip head screws).
3. See Figure 2 and Table 2 for permissible module slot location.
4. When installing a module, slide it vertically down between the module guides and press firmly into place.
5. Open the hinged top. Make sure the spring guard connection is resing on the guard shield, connecting one half of the guard shield to the other.
6. When removing a module, grasp it at either end and pull up. An end-to-end rocking motion may be used to free the module from the connector.

Table 2. Module Installation Locations

MODULE DESCRIPTION	PERMISSABLE SLOTS	MODULE DESCRIPTION	PERMISSABLE SLOTS
DC SIGNAL COND.	A B C D	CALIBRATION MEMORY (OPTION -04)	L M N
AC AVG. CONV (OPTION -01)	A B C D	BIT SERIAL (OPTION -06)	L M N
R.M.S. CONV. (OPTION -091)	A B C D	PARALLEL INTERFACE (OPTION -06)	L M N
CURRENT SHUNT (OPTION -03)	A B C D	IEEE INTERFACE (OPTION -05)	L M N
OHMS CONV. (OPTION -02)	A B C D	STATIC CONTROLLER M.I.S.-7190K	A B C D L M N
FILTER	G	TEST MODULE M.I.S.-7191K	A B C D L M N
A/D CONV.	H	EXTENDER M.I.S.-7011K	ANY
BUS INTERCONNECT	K	BUS INTERCONNECT & MONITOR M.I.S. 7013K	ANY
ISOLATOR (OPTION -081)	K		
CONTROLLER	L M N		

Table 3. Real Time Line Access

REAL TIME LINE	FUNCTION	TEST POINT ACCESS
RT0	Ohms Guard	
RT1	Ohms output, Current output, DC Amp input hi, AC RMS and AVG input hi.	Current Shunts (TP3)
RT2	Reference Common	DC Signal Conditioner (TP8) Active Filter (TP1) A/D Analog (TP6)
RT3	AC RMS, AVG input lo, Current output lo.	
RT4	Reference -7V, A/D to Ohms Converter.	Analog A/D Converter (TP7)
RT5	A/D input, A/F output.	Analog A/D Converter (TP4)
RT6	DC Amp output, AC RMS and AVG. output, A/F in.	DC Signal Conditioner (TP4) RMS Converter (TP2)
RT7	External Reference hi.	
RT8	External Reference lo.	
AR	Analog Return	Current Shunts (TP1)

Monitoring Analog Signals

When testing 8500 series modules with the Static Controller, analog signals will often need to be sourced or monitored at front or rear panel terminals and interbus real time (RT) lines. Access to RT lines can be made in several locations:

1. Bus Interconnect and Monitor (M.I.S. 7013K): all RT lines. (RT1 connects only to slots A, B, C, D, on the Analog Bus.)

2. Test points in individual modules: most RT lines. (See Table 3).

3. Extender Assembly (M.I.S. 7011K): access RT lines on pins. (See Table 4.)

STATIC CONTROLLER USE (5100 SERIES)

Function

The Static Controller will simulate the Digital Controller in the 5100, and use the address (IC) and bidirectional data (ID) information on the Internal Digital Interbus.

PCB Assembly, Installation and Removal

Use the following procedure when changing modules in the 5100 series calibrator:

1. Press power switch to OFF. Disconnect line cord.

2. Remove top cover (6 screws on top, 2 on each side).

3. Remove colored plastic pcb card retainers from guard cover. Remove guard cover (6 screws).

4. Insure that guard covers are removed from the Static Controller module. Install Static Controller in any rear (Digital) compartment slot. Slide evenly through card guides and press firmly into place (switches facing forward).

5. Rear most slot should be reserved for any interface pcb assembly to be tested. Refer to respective assembly check-out procedures for further installation technique.

6. DO NOT apply power at this time. The following considerations are applicable to any module being tested:

   — When removing or installing an assembly, the power must be off. Damage to static sensitive devices could otherwise result.

   — The 5100 calibrator's front panel will offer no control or display indications while the Static Controller is used in place of the Controller.

7. To remove a pcb assembly from the digital compartment, grasp it firmly at each corner and pull straight up.

Table 4. Module Troubleshooting with the Static Controller

MODULE	TABLE
Active Filter	5
A/D Converter	6
DC Signal Conditioner	7
AC/DC Converter (AVG)	8
AC/DC Converter (RMS)	9
Current Shunts	10
Ohms Converter	11
Parallel Interface	12
Bit Serial Asynchronous Interface (5100 or 8500)	13

Table 5. Active Filter

The Static Controller can be used with the Active Filter to determine filter output levels and characteristics, given a known input. Interbus address (IC), data (ID), and handshake connections and responses are simultaneously verified.

Insure that power is removed from the 8500 series DMM whenever modules are removed or installed.

Modules Required

1. Active Filter (Slot G).
2. Static Controller (Slot L, M, or N).
3. Bus Interconnect or Bus Interconnect Monitor (Slot K).

Test Set-Up

1. Connect a dc voltage source (0 ± 20V) to RT6 (HI) and RT2 (LO) on the Bus Interconnect Monitor. To check filter's effectiveness, supply ac on the above mentioned dc line.
2. Connect a dc voltmeter (0 ± 20V) to RT5 (HI) and RT2 (LO). Alternately, TP3 (HI) and TP1 (LO) on the Active Filter can be used. Use any Fluke voltmeter or equivalent.
3. Apply power to the 8500 series DMM and associated test equipment.

Static Controller Set-Up

1. Address the Active Filter from the IC switches:

IC6	IC5	IC4	IC3	IC2	IC1	IC0
0	0	1	1	0	1	0

2. Set data (ID) switches for filter desired.

   ID0 to 1: Filter Bypass (High Frequency filtering)

   ID1 to 1: Z Filter (7 Hz low cut-off)

Static Controller Set-Up (cont)

   ID2 to 1: Y Filter (1 kHz to 70 Hz low cut-off)

   ID3 to 1: Must be high for any of the above filters.
   Must be low for external reference.

e.g.

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
0	0	0	0	1	0	0	1

3. Data Switch should be toggled to DATA OUT. Toggle to CONTROL OUT. ACK lights. Toggle out of CONTROL OUT.
4. The Output voltage at RT5 should now equal the input at RT6.

External Reference Set-Up

1. Apply a jumper between EXT REF LO on the 8500 DMM's rear panel and INPUT LO on the front panel.
2. Connect the dc source to the EXT REF HI and LO terminals.
3. HI or LO outputs from the Active Filter must be checked separately. Toggle ID switches on the Static Controller as follows:

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0	
0	0	1	0	0	0	0	1	1
0	0	0	1	0	0	0	1	2

1 EXT REF HI
2 EXT REF LO

4. Toggle to CONTROL OUT. External reference input should equal the Active Filter's output.

Table 6. A/D Converter

The Static Controller can be used in conjunction with the A/D Converter to verify proper operation of address, data, and handshake lines. Digital switching circuit operation is accurately verified. Polarity bits returned are displayed on the Static Controller's LED's.

Insure that power is removed from the 8500 series DMM whenever modules are removed or installed.

Modules Required

1. A/D Converter (Slot H).
2. Static Controller (Slot L, M, or N).
3. Bus Interconnect or Bus Interconnect Monitor (Slot K).
4. Active Filter (Slot G).

Test Set-Up

1. Connect a dc voltage source to RT6 (HI) and RT2 (LO) on the Bus Interconnect Monitor Board.
2. Connect a dc voltmeter to RT5 (HI) and RT2 (LO) on the Bus Interconnect Monitor. Alternately, use TP4 (HI) and TP6 (LO) on the A/D Converter (Analog).

Table 6. A/D Converter (cont)

Verify Correct Operation of the Active Filter

1. Address the Active Filter from the Static Controller's IC switches:

IC6	IC5	IC4	IC3	IC2	IC1	IC0
0	0	1	1	0	1	0

2. Insure that Control switch is in DATA OUT. Set ID switches to:

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
0	0	0	0	1	0	0	1

3. Toggle to CONTROL OUT. ACK will light. Active Filter should now output the same dc level on RT5 as is applied on RT6.

Address and Program the A/D Converter

ID switch settings control:

ID0= 1	Reset Counter
ID1= 1	Auto Zero
ID2= 0	Buffer Input
ID2= 1	Remainder Input
ID3= 1	Channel X (Auto Zero-R-1 & 3)
ID3= 0	Channel Y (R-2 & 4)

Select X channel first.

1.

IC6	IC5	IC4	IC3	IC2	IC1	IC0
0	0	1	1	1	0	0

2.

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
0	0	0	0	1	1	1	1

3. Toggle to CONTROL OUT. Set the A/D Converter (Analog) for buffer input, channel X storage.

4.

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
0	0	0	0	1	0	0	0

5. Toggle to CONTROL OUT.

6. Toggle to DATA IN.

7. Set the indirect address from the Static Controller's IC switches.

IC6	IC5	IC4	IC3	IC2	IC1	IC0
0	0	0	0	1	1	0

The CONTROL OUT switch can now be toggled to receive polarity bit indications from the A/D Converter (Analog). ID7 (LED) will light when a positive polarity bit is returned. Toggle CONTROL OUT six times; the last application will reset the control logic.

Address and Program the A/D Converter (cont)

8. Returned bits will identify the dc input voltage applied on RT6. In normal instrument operation, this is the output voltage of either the DC Signal Conditioner or an AC Converter. Cardinal point outputs from these modules are:

RANGE	OUTPUT
100 MV (DC only)	6.4V
1V	8.0V
10V	10V
100V	12.5V
1000V	15.6V

9. Each successive application of CONTROL OUT will switch a new precision current in the Summing Node of the A/D Converter (Analog). If application of the current switch results in a bit returned opposite in polarity to that selected for a step, that switch will be opened. Otherwise, it will remain closed. The next switch will then be closed to add another precision current and again check for polarity change. The bit total (add positive bit returns on ID7) should equal the nearest possible lower combination to the input voltage. For example, ID7 on in steps 2, 3, and 5 would signify a voltage greater than 8.125V and less than 8.75V.

Polarity Bit Identification

CONTROL OUT Step	1	2	3	4	5	6
Summing Node Bit Checked	10 BIT	5 BIT	2.5 BIT	1.25 BIT	.625 BIT	LOGIC RESET

10. The same six steps can now be followed for the remainder stored in channel X. The bit total for any remainder will be inaccurate due to capacitor leakage in the storage channel and the significantly slower operation of the Static Controller's commands. Remainder channel basic operation can be verified, though. Use the following procedure:

- DATA OUT.
- Direct Address (IC) 0 0 1 1 1 0 0
- Remainder Input (Store new remainder in channel Y). (ID) 0 0 0 0 0 1 0 0
- CONTROL OUT. DATA IN.
- Indirect Address.
- Toggle CONTROL OUT six times for polarity bit return in ID7.

Check Channel Y

The same procedures for buffer input and remainder channel verification can be performed with storage in channel Y. Repeat steps 1-10, under "Address and Program the A/D Converter (Analog)". In step 4, set ID3 to 0.

Table 7. DC Signal Conditioner

The Static Controller can be used to verify proper DC Signal Conditioner output levels, given a known input at the instrument's input terminals. Address, data, and handshake signals on the interbus are concurrently confirmed.

Insure that power is removed from the 8500 series DMM whenever modules are removed or installed.

Modules Required

1. DC Signal Conditioner (Slot A, B, C, or D).
2. Static Controller (Slot L, M, or N).
3. Bus Interconnect or Bus Interconnect Monitor (Slot K).
4. A/D Converter. (If this module is not included in the instrument, a jumper must be placed between RT2 and analog return (AR)).

Test Set-Up

1. Connect a dc voltage source to front input terminals. If all ranges are to be checked, a source output of 1000V dc will be required in a later step.
2. Connect a dc voltmeter to RT6 (HI) and RT2 (LO) on the Bus Interconnect Monitor Board. Alternately, TP4 (HI) and TP8 (LO) on the DC Signal Conditioner may be used.
3. Apply power to the 8500 series DMM and associated test equipment.

Static Controller Set-Up

1. Address the DC Signal Conditioner from the Static Controller's IC switches as follows:

IC6	IC5	IC4	IC3	IC2	IC1	IC0
0	0	1	1	0	0	1

Static Controller Set-Up (cont)

2. Set ID switches on the Static Controller for the desired range as follows:

DC Range Settings

RANGE	ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
100 MV	0	0	0	0	0	1	1	0
1V	0	0	0	0	1	0	1	0
10V	0	0	0	0	1	1	1	0
100V	0	0	0	0	1	0	0	0
1000V	0	0	0	0	1	1	0	0

3. Set to DATA OUT.
4. Toggle CONTROL OUT switch up. ACK light will come on, signifying that the DC Signal Conditioner is set on the range desired. Cardinal point inputs (e.g. 10V on the 10V range) will yield the following outputs:

RANGE (=input)	OUTPUT	GAIN
100 mV	6.4V	X64
1V	8.0V	X8
10V	10V	X1
100V	12.5V	÷8
1000V	15.6V	÷64

Table 8. AC/DC Converter (AVG)

The Static Controller can be used to verify proper Avg. Converter dc output levels, given known inputs at the instrument's front panel terminals. Interbus address (IC), data (ID), and handshake connections and responses are thereby also verified.

Power must be removed for the instrument whenever modules are installed or removed. AC/DC Converter (RMS) must not be installed.

Modules Required

1. AC/DC Converter (AVG) (Slot A, B, C, or D).
2. Static Controller (Slot A, B, C, or D-facing backwards).
3. Bus Interconnect Monitor (use optionally for ease of access to RT lines - Slot A, B, C, or D).

Test Set-Up

1. Connect an AC source to the front panel input terminals for the 8500 series DMM. If all ranges are to be checked, a maximum of 1000V ac can be used in a later step.
2. Connect a dc voltmeter to RT2 (LO) and RT6 (HI) on the Bus Interconnect Monitor Board. Any Fluke voltmeter or equivalent may be used.
3. Apply power to the 8500 series DMM and associated test equipment.

Table 8. AC/DC Converter (AVG) (cont)

Static Controller Set-Up

1. Address the AC/DC Converter (Avg.) from the Static Controller's IC switches as follows:

IC6	IC5	IC4	IC3	IC2	IC1	IC0
0	0	1	0	1	1	0

2. Set ID switches on the Static Controller for the range, filter, and input source desired.

RANGE	ID5	ID4	ID3
1V	1	1	1
10V	1	1	0
100V	1	0	1
1000V	0	1	1

	ID2	ID1	ID0	
Filter On	0	0	1	AC Input (Binding Posts)
Filter Off	1	1	0	A AC Input (RT1)

3. I.e., set ID switches to 0 0 1 1 0 0 0 1. Insure that DATA switch is set to DATA OUT. Toggle CONTROL OUT switch up. After the ACK light comes on, toggle CONTROL OUT down. The Avg. Converter is now set to measure ac voltage from the front input terminals, with filter on, in the 10V range.

4. The output will be read in dc volts. Given cardinal point inputs (e.g. 10V on the 10V range), the following outputs can be expected:

RANGE (=Input)	OUTPUT	GAIN
1V	8.0V	X8
10V	10.0V	X1
100V	12.5V	÷8
1000V	15.6V	÷64

Table 9. AC/DC Converter (RMS)

The Static Controller can be used to verify proper RMS Converter dc output levels, given known inputs at the instrument's front panel terminals. Interbus address (IC), data (ID), and handshake connections and responses are thereby also verified.

Power must be removed for the instrument whenever modules are installed or removed. AC/DC Converter (AVG) must not be installed.

Modules Required

1. AC/DC Converter (RMS) (Slot A, B, C, or D).
2. Static Controller (Slot A, B, C, or D-facing backwards).
3. Bus Interconnect Monitor (use optionally for ease of access to RT lines - Slot A, B, C, or D).

Test Set-Up

1. Connect an ac source to the front panel input terminals for the 8500 series DMM. If all ranges are to be checked, a maximum of 1000V ac can be used in a later step.
2. Connect a dc voltmeter to RT2 (LO) and RT6 (HI) on the Bus Interconnect Monitor Board. Alternately, make connections to TP1 (LO) and TP2 (HI) in the RMS Converter module. Any Fluke voltmeter or equivalent may be used.
3. Apply power to the 8500 series DMM and associated test equipment.

Static Controller Set-Up

1. Address the RMS Converter from the Static Controller's IC switches as follows:

IC6	IC5	IC4	IC3	IC2	IC1	IC0
0	0	1	0	1	0	1

Static Controller Set-Up (cont)

2. Set ID switches on the Static Controller for the range, filter, and input source desired.

RANGE	ID5	ID4	ID3
1V	1	1	1
10V	1	1	0
100V	1	0	1
1000V	0	1	1

	ID2	ID1	ID0	
Filter On	0	0	0	DC cpld AC
Filter Off	1	0	1	AC V (BP Input)
		1	0	RT1 input for A

3. I.e., set ID switches to 0 0 1 1 0 0 0 1. Insure that DATA switch is set to DATA OUT. Toggle CONTROL OUT switch up. After the ACK light comes on, toggle CONTROL OUT down. The RMS Converter is now set to measure ac voltage from the front input terminals, with filter on, in the 10V range.

4. The output will be read in dc volts. Given cardinal point inputs (e.g. 10V on the 10V range), the following outputs can be expected:

RANGE (=Input)	OUTPUT	GAIN
1V	8.0V	X8
10V	10.0V	X1
100V	12.5V	÷8
1000V	15.6V	÷64

Table 10. Current Shunts

The Static Controller can be used to address and program the Current Shunts module. An output dc voltage representative of given input currents can then be monitored.

Insure that the power is removed from the DMM whenever modules are removed or installed.

Modules Required

1. Current Shunts (Slot A, B, C, or D).
2. Static Controller (Slot A, B, C, or D-facing backwards).
3. A/D Converter (Slot H), if this module is not in the instrument, place a jumper between RT2 and analog return (AR).
4. Bus Interconnect Monitor (Slot A, B, C, or D).

Test Set-Up (DC Current)

1. Connect a dc current source to SOURCE HI and LO on the front panel of the 8500 series DMM. Strapping to SENSE terminals may be left in place.
2. Connect a dc voltmeter to RT1 (HI) and RT2 (LO) on the Bus Interconnect Monitor. Use any Fluke voltmeter or equivalent. Alternately, use TP3 (HI) and TP1 (LO) on the Current Shunts module.
3. Apply power to the 8500 series DMM and associated test equipment.

Static Controller Set-Up

1. Address the Current Shunts from the Static Controller's IC switches as follows:

IC6	IC5	IC4	IC3	IC2	IC1	IC0
0	0	0	1	0	1	1

2. Place the Data switch in the DATA OUT position. Three steps will be required for each current measurement; ID switches will be changed each time. Toggle the CONTROL OUT switch up after each new ID switch positioning.
3. Reset is the first step in any current measurement. Set ID switches to:

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
0	0	1	1	1	1	1	1

Static Controller Set-Up (cont)

4. Voltage Check is the next step. An error code will be generated if more than 50V is measured.

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0
0	0	0	0	0	0	0	0

5. The last step is to set range and reference information.

RANGE	ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0*
100 uA	0	0	1	1	0	1	1	0
1 mA	0	0	1	0	0	1	1	0
10 mA	0	0	0	1	0	1	1	0
100 mA	0	0	1	1	0	0	1	0
1A	0	0	1	1	0	1	0	0

*ID0 = for DC Ref/1 for AC Ref

6. Apply current input at the cardinal point for the range selected.
7. Full scale output voltages are listed below as an aid in determining basic circuit operation.

RANGE	FULL SCALE I IN	FULL SCALE E_{OUT}
100 uA	312 uA	.8V
1 mA	2.5 mA	1.0V
10 mA	20 mA	1.25V
100 mA	160 mA	1.6V
1 A	1.28A	2.0V

AC Current

Follow the same procedure as noted above for ac current measurement. Not the following exceptions:

1. Place a jumper between RT2 and RT3 on the Bus Interconnect and Monitor Board.
2. Set ID0 on the Static Controller to 1 when setting range and reference information (see step 5).

Table 11. Ohms Converter

The Ohms Converter outputs a current through an unknown resistance; the voltage across the unknown resistance is proportional to the value of that resistance. Proper module operation can be ascertained by first applying a known reference resistance and a reference voltage. Two further voltage values are then measured to compute the unknown resistance. Use the ohms formula:

$$Rx = R_{REF} \frac{V0}{V1 - V2}$$

R_x = unknown resistance

R_{REF} = reference resistance

V_0 = a value between 0 and -15V.

V_1 = reference voltage (18.6V ± 0.2V on 10, 100, 10k, 1M ranges)

(2.3V ± 0.2V on 1k, 100k, 10M, 100M ranges)

V_2 = a value less than 100 mV. (V2 is not used in the 1M, 10M and 100M ranges.)

The Static Controller can be used to set-up measurement of V0, V1, and V2. The ohms formula can then be applied to compute a resistance value for comparison to a known resistance input.

Insure that power is removed from the instrument whenever modules are removed or installed.

Modules Required

1. Ohms Converter (Slot A, B, C, or D).
2. Static Controller (Slot A, B, C, or D-facing backwards).
3. Bus Interconnect Monitor (Slot A, B, C, or D).
4. A/D Converter (Slot H). If this module is left out, normal test procedures may be followed if -7V is supplied to RT4.
5. DO NOT install the Isolator module.

Test Set-Up

1. Connect the resistance to be checked (R_x) across front panel HI and LO INPUT terminals. SENSE INPUT HI must be strapped to SOURCE INPUT HI; SENSE INPUT LO must be strapped to SOURCE INPUT LO.
2. Connect a dc voltmeter to RT1 (HI) and RT2 (LO) on the Bus Interconnect Monitor.
3. Apply power to the 8500 series DMM and associated test equipment.

Static Controller Set-Up

1. Address the Ohms Converter from the Static Controller's IC switches as follows:

IC6	IC5	IC4	IC3	IC2	IC1	IC0
0	0	0	1	1	1	0

Static Controller Set-Up (cont)

2. Three voltage checks (V0, V1, V2) will be carried out for each resistance range to be tested. ID0, ID1, ID2 will specify which voltage is to be measured. ID3 - ID7 determine the range.
3. Leave DATA OUT switch toggled up.
4. Each time ID switches are changed, toggle CONTROL OUT switch up. ACK LED will come on. Toggle CONTROL OUT down; take reading.
5. For example, to measure a 1k ohm resistor:

   - Set ID switches for 1k range and V1. Note V1 on dc voltmeter. (2.3074V in this instance.)

   - Change ID0 - ID2 to read V2. (5.3 mV here.)

   - Change ID0 - ID2 to read V0. (-1.151V.)

   - Using the ohms formula and the Reference Resistances listed below, compute R_x (actually the 1k ohm resistor).

$$Rx = 2 \times 10^3 \frac{1.151}{2.3074 - .0053}$$

$$= 999.9 \text{ ohms}$$

6. Each range can similarly be checked with appropriate resistance values. Consult Ohms Range Settings listed below for necessary ID switch range positioning.

Reference Resistance

OHMS RANGE	10	100	1K	10K	100K	1M	10M	100M
R_{REF}	2K	2K	2K	256K	256K	4.091M	4.091M	32.768M

Ohms Range Settings

RANGE	ID7	ID6	ID5	ID4	ID3	*ID2	*ID1	*ID0
10	0	1	1	0	0	1	0	1
100	0	1	1	0	0	1	0	1
1k	0	1	1	1	0	1	0	1
10k	1	1	0	0	0	1	0	1
100k	1	1	0	1	0	1	0	1
1M	1	1	1	0	0	1	0	1
10M	1	1	1	1	0	1	0	1
100M	1	0	1	1	0	1	0	1

*Read V_1

Change:	ID2	ID1	ID0	
To:	1	1	0	Read V0
	0	1	1	Read V2

Table 12. Parallel Interface

The Static Controller can be used with the Parallel Interface module to determine data transfer and proper operation of interface gates. Insure that power is removed whenever assemblies are removed or installed in the instrument.

Assemblies Required

1. Parallel Interface (Slot N).
2. Static Controller (Slot L, or M).

Test Set-Up

1. Jumper Personality Card and I/O Connector as described below.
2. Data responses will be read on the Static Controller's LED's (ID).
3. Apply power.

Static Controller Set-Up

1. For each of the following steps, first set address (IC) and Data Out (ID) switches, if any, on the Static Controller. Toggle to DATA OUT or DATA IN.
2. Toggle CONTROL OUT. Read data in where appropriate on the ID LED's.
3. The procedure listed below will verify operation of all gates except U2, pin 10-11 in the Parallel Interface.

Personality Card Interconnections (J2)

When used with the Static Controller, the Parallel Interface must incorporate unique personality card interconnections. There are two advisable methods of doing this:

1. Use the General Purpose Personality Card (M.I.S.-4071), or
2. Use any 40 pin plug that will fit J2 on the Parallel Interface and provide jumper connection points.

Make the following pin interconnections:

2 - 14 - 15 - 8 - 9

33 - 4 - 5

34 - 10

32 - 38

25 - 40

29 - 37

27 - 30 - 31

28 - 13

6 - 39

23 - 11 - 12 - 21

18 - 17 - 16

Input/Output Connector (J1)

The following I/O interconnections must be made. Use the modified cable connector plug supplied with the Parallel Interface to access connection points.

1. Pins 46 - 14, 45 - 15, 44 - 16, 43 - 17, 42 - 18, 41 - 19, 40 - 20, 39 - 21
   Pins 22 - 6, 23 - 7, 24 - 8, 25 - 9, 50 - 10, 49 - 11, 48 - 12, 29 - 31, 47 - 13
2. Add a ceramic .01 uF capacitor between pins 1-5.

Parallel Interface Test Procedure

STEP	ACTION	ADDRESS	DATA OUT	DATA IN
1	Soft Reset	IC5,3,2 =1	ID7-0 =1	
2	Check Status	IC6,4,2 = 1		ID7-4=1
3	Enable Interrupts	IC5,3,2 = 1	ID7=0 ID6-0=1	
4	Check Status	IC6,4,2=1		ID7-6=1 ID5-4=0
5	Load Upper Data Out	IC5,3,0=1	ID7,5,3,1=1 ID6,4,2,0=0	
6	Check Status	IC6,4,2=1		ID7,5,4=0 IC6=1
7	Load Lower Control Out	IC5,3,1=1	ID7,5,3,1=0 ID6,4,2,0=1	

NOTE: An interrupt occurs. Toggle INA switch. ACK LED lights.

8				ID2=1
9	Check Status	IC6,4,2=1		ID7,6,5,4=1
10	Input Data	IC6,4,0=1		ID7,5,3,1=1 ID6,4,2,0=0
11	Check Status	IC6,4,2=1		ID7,6,4=1 ID5=0
12	Input Control	IC6,4,1=1		ID7,5,3,1=0 ID6,4,2,0=1
13	Check Status	IC6,4,2=1		ID7,6=1 ID5,4=0

14 Load Upper Data Out (repeat step 5, output a different bit pattern)

15 Load Lower Control Out (repeat step 7, output a different bit pattern)

16 Interrupt occurs. Toggle INA switch. ACK LED lights. ID2=1.

17 Input Data (repeat step 10, read same pattern as sent in step 14)

18 Input Control (repeat step 12, read same pattern as sent in step 15)

19 Repeat steps 14-18 with differenct bit patterns until there is no chance of bits hanging.

20 Repeat steps 1 and 2.

Table 13. Bit Serial Asynchronous Interface (5100 or 8500)

The Static Controller can be used in conjunction with the Bit Serial (RS 232) interface to check baud rate and transfer of data. Ensure that power is removed from the instrument whenever assemblies are installed or removed.

Modules Required

1. Static Controller (Slot L or M on 8500/Digital Compartment on 5100).
2. Bit Serial Asynchronous Interface (rear slot).

Test Set-Up

1. Data responses will be indicated by the Static Controller's LEDs.
2. The baud rate may be checked with an oscilloscope at TP3 on the interface.
3. Tie pins 2 and 3 together on the interfaces I/O connector (J1).
4. Apply power.

CAUTION

If the Isolator and Bit Serial Asynchronous Interface are installed, replacement of the Isolator by the Bus Interconnect Monitor PCB may allow a hazardous common mode voltage to appear on the output connector of the interface.

Static Controller Set-Up

1. Note that ID7 will be valid only if parity is selected (see Bit Serial Schematic Diagram - M.I.S. 1070).
2. The following steps can be used to verify data transfer to and from the Bit Serial Interface. Toggle CONTROL OUT after each address and data setting.

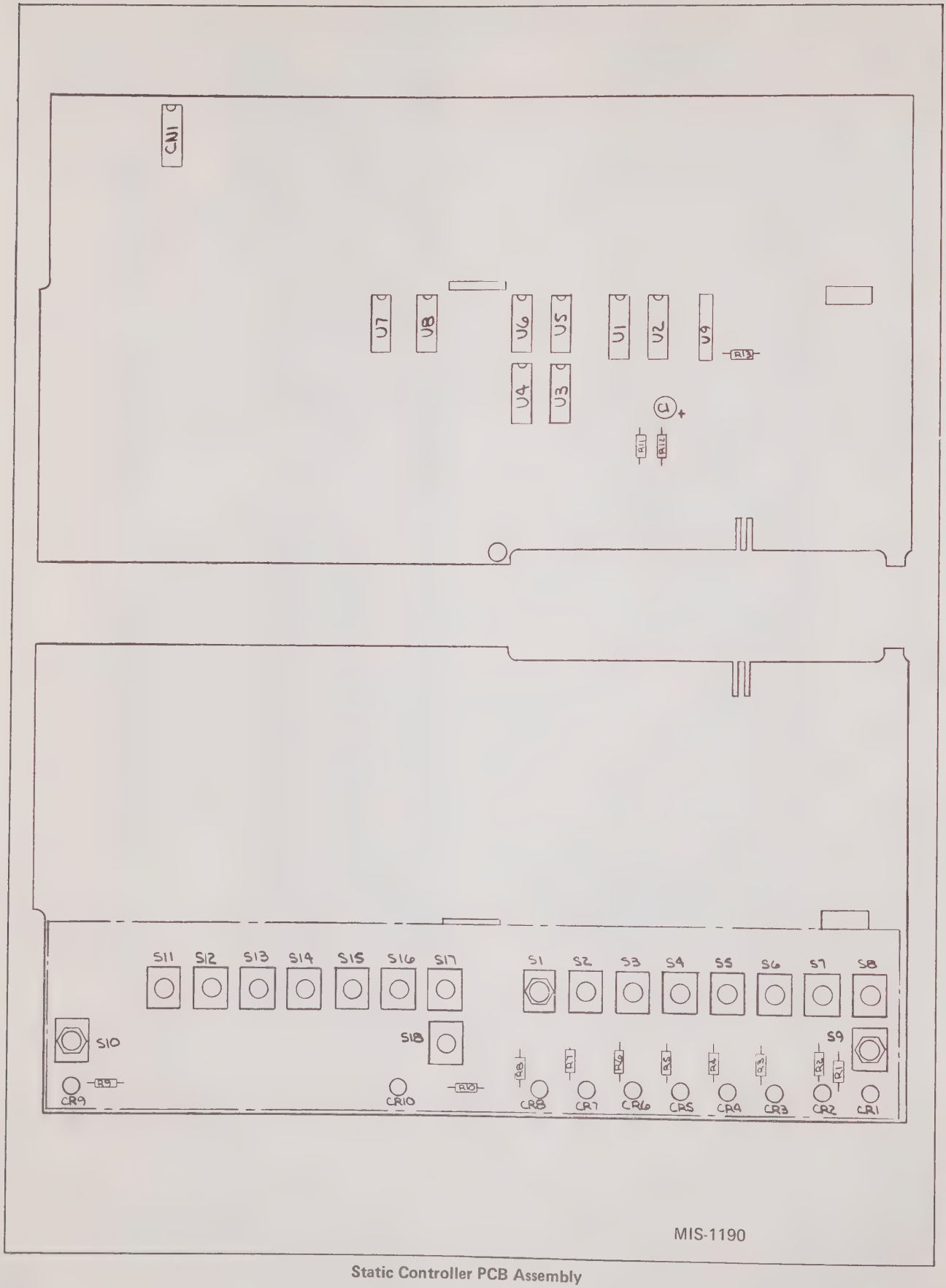
Bit Serial Interface Test

STATIC CONTROLLER SETTINGS

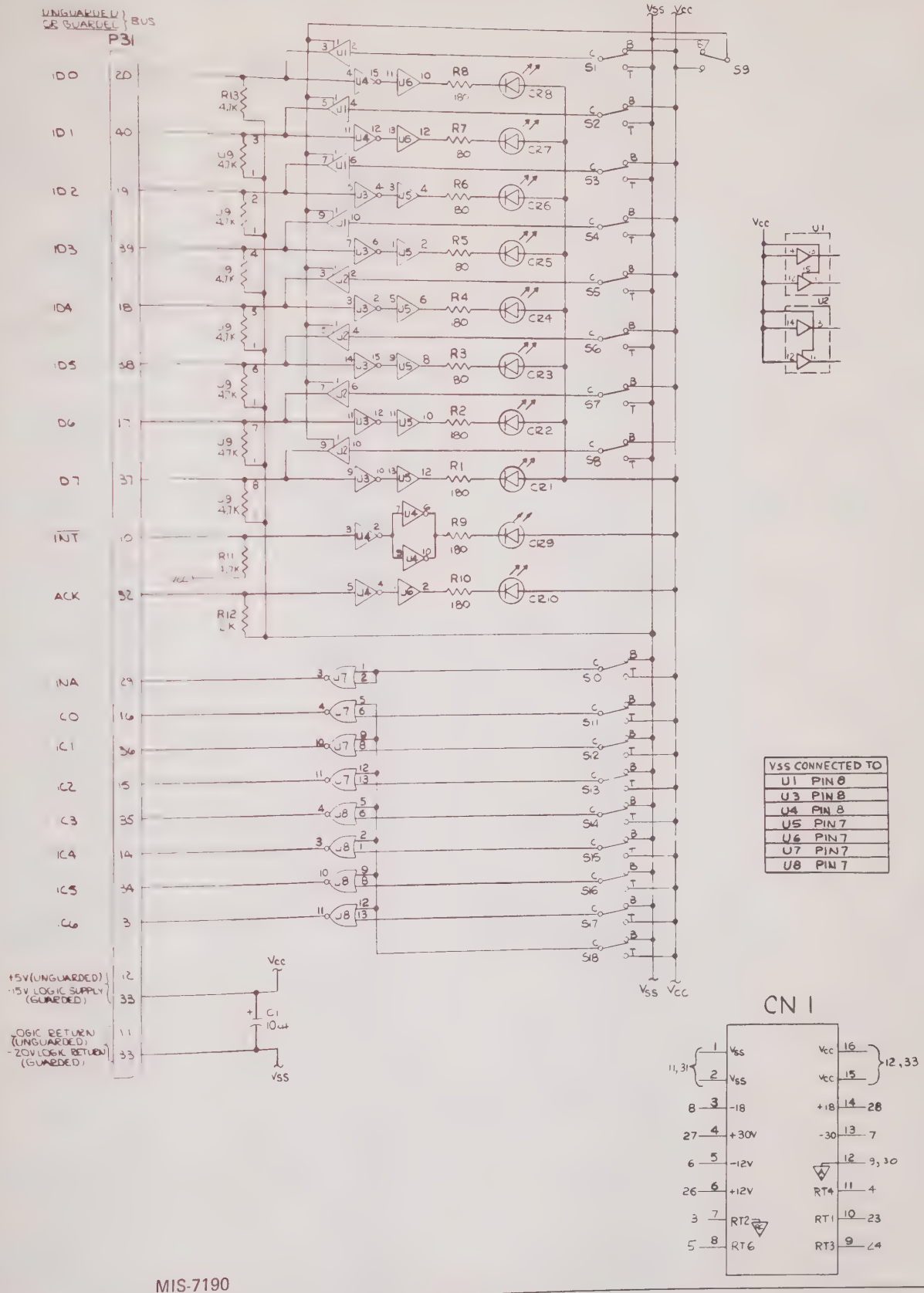
STEP	ADDRESS	DATA	ACTION	RETURN DATA
1	IC5,4,2=1	ID7=0	Set Interrupts	
		ID7=1	Disable Interrupts	
2	IC6,4,3=1	ID7-ID0 (any pattern)	Send DATA OUT Toggle CONTROL OUT	
NOTE: An interrupt will now occur (INT LED on). Toggle the INA switch. ACK LED will light.				
3			DATA IN	ID2 on.
4	IC6,4,1=1		DATA IN	ID7-ID0) (same as step 2)
5	IC6,4,0=1		Check status ID2 on.	
NOTE: This step verifies that the transmitter buffer is empty.				
6	IC6,4,3=1	ID7-ID0 (any pattern)	Send DATA OUT Toggle CONTROL OUT	
	INT LED on.			
7	IC6,4,0=1		Check Status buffer empty Data available	ID2 on. ID0 on.
NOTE: Toggle INA. ACK LED on.				ID2 on.
8	IC6,4,1=1		DATA IN	ID7-ID0 (same as step 6)
NOTE: Continue for different ID7-ID0 patterns.				

Static Controller PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C1	CAP, TA, 10UF +/-10%, 15V	193623	56289	196D106X0015KA1	1		
CR1	LED, RED	428623	12040	59NSL-5046	10	2	
CR2	LED, RED	428623	12040	59NSL-5046	REF		
CR3	LED, RED	428623	12040	59NSL-5046	REF		
CR4	LED, RED	428623	12040	59NSL-5046	REF		
CR5	LED, RED	428623	12040	59NSL-5046	REF		
CR6	LED, RED	428623	12040	59NSL-5046	REF		
CR7	LED, RED	428623	12040	59NSL-5046	REF		
CR8	LED, RED	428623	12040	59NSL-5046	REF		
CR9	LED, RED	428623	12040	59NSL-5046	REF		
CR10	LED, RED	428623	12040	59NSL-5046	REF		
MP1	SPACER, NYLON	441790	89536	441790	10		
MP2	CASE HALF, MODULE	402990	89536	402990	2		
MP3	GUARD, FRONT	383356	89536	383356	1		
MP4	GUARD, REAR	383364	89536	383364	1		
MP5	FRONT PANEL	419655	89536	419655	1		
R1	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	10		
R2	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	REF		
R3	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	REF		
R4	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	REF		
R5	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	REF		
R6	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	PEF		
R7	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	REF		
R8	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	REF		
R9	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	REF		
R10	RES, COMP, 180 +/-5%, 1/4W	147942	01121	CB1815	REF		
R11	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	2		
R12	RES, COMP, 2K +/-5%, 1/4W	202879	01121	CB2025	1		
R13	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
S1	SWITCH, DPDT	115113	95146	MTA-206N	18		
S2	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S3	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S4	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S5	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S6	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S7	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S8	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S9	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S10	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S11	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S12	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S13	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S14	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S15	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S16	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S17	SWITCH, DPDT	115113	95146	MTA-206N	REF		
S18	SWITCH, DPDT	115113	95146	MTA-206N	REF		
U1	Ⓐ IC CMOS TRISTATE NON INV BUFFERS	407759	04713	MC14503CP	2	1	
U2	Ⓐ IC CMOS TRISTATE NON INV BUFFERS	407759	04713	MC14503CP	REF		
U3	Ⓐ IC, CMOS, HEX BUFFER/INVERTERS	381848	04713	MC14049CP	2	1	
U4	Ⓐ IC, CMOS, HEX BUFFER/INVERTERS	381848	04713	MC14049CP	REF		
U5	IC, TTL, HEX BUFFER/DRIVER	328021	01295	SN7417N	2	11	
U6	IC, TTL, HEX BUFFER/DRIVER	328021	01295	SN7417N	REF		
U7	Ⓐ IC, CMOS QUAD 2 INPUT NOR GATES	355172	04713	MC14001CP	2	1	
U8	Ⓐ IC, CMOS QUAD 2 INPUT NOR GATES	355172	04713	MC14001CP	REF		
U9	RESISTOR NETWORK 4.7K	412916	89536	412916	1		
XU1	SOCKET, 16 PIN, DIP	370312	91506	316-AG39D	1		



Static Controller PCB Assembly



MIS-7190

Static Controller PCB Assembly (cont)

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Option —01
AC/DC Converter (Averaging)

601-1. INTRODUCTION

601-2. The Average Responding AC Converter is used to convert ac signals to dc levels which can be measured by the A/D Converter. A maximum input of 1000V rms (or 2 x 10^7 Volt-hertz product, whichever is less) may be applied with resolutions available to one microvolt. Input impedance is 1 MΩ with less than 100 pf shunt capacity.

601-3. SPECIFICATIONS

601-4. Table 601-1 lists the specifications for the —01 option.

601-5. INSTALLATION

601-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing modules. The interconnect diagram in Section 8 contains a table listing the permissible and preferred slots for each module.

601-7. OPERATING NOTES

601-8. The operating instructions given in Section 2 of this manual apply for operation of the instrument with the AC/DC Converter (Averaging) installed. The lowest range available through the average responding ac converter is the 1V range.

601-9. For rated accuracy below 400 Hz, the slow filter (FILTER LED on) must be selected. This selects additional filtering in the ac converter as well as in the Active Filter module. External reference measurements may be made as described in Section 2 but the external reference inputs must be dc only.

601-10. Once the instrument is zeroed for DC Volts, no additional zeroing is required for AC Volts measurements. Using the Offset function as an AC Volts zero could result in greater error due to the nature of the floor digits specifications.

601-11. THEORY OF OPERATION

601-12. The AC/DC Converter accepts signals either from the input terminals or from the optional current shunts module (RT1 and RT3). Refer to Figure 601-1. Input signals are applied to the input range amplifier, U1, through a dc blocking capacitor, C1, and a 2 MΩ resistor, R2. R2 establishes the input resistance of the amplifier. U1 is a voltage amplifier controlling a current source, Q4 and Q6. Q4 and Q6 change the low impedance of U1 to a high impedance for driving CR10 and CR11. The high impedance at the collectors of Q4 and Q6 minimizes error introduced by the nonlinearity of CR10 and CR11, which have a relatively low impedance.

601-13. Distortion of the waveform occurs at the collectors of Q4 and Q6 due to the nonconducting regions of CR10 and CR11. During the portion of the waveform in which CR10 and CR11 are not conducting, the feedback path of the amplifier is effectively broken and the gain of the amplifier becomes very high. The time required for the waveform to cross the nonconducting region is determined by the slew rate of the amplifier. When CR10 and CR11 are conducting, the gain of the amplifier is controlled by R18 and associated parallel resistors as selected by K3, K4, and K5.

601-14. U6 is configured as a differential amplifier having a gain of approximately 8 times the average-to-rms scaling factor of 1.11. Signals from CR10 and CR11 are applied to U6 through a matched temperature coefficient resistor set which provides the gain setting for U6, and filtering with capacitors C18, C19, C21, and C22. When the slow filter is selected, additional filtering, C17 and C20, is switched in by Q12 and Q13.

CHECK ERRATA

CHANGE # 24

Table 601-1. AC/DC Converter (Averaging) Specifications Accuracy

ACCURACY

(Refer to the Specifications table in Section 1 for required environmental conditions)

Accuracy (0.1% of Range to Full Scale) ± (% of Input + No. of Digits)

Frequency	24 Hours		90 Days		1 Year	
	0 to 500V	Above 500V	0 to 500V	Above 500V	0 to 500V	Above 500V
30 Hz to 50 Hz	0.3 + 5	0.4 + 5	0.5 + 5	0.55 + 5	1.0 + 5	1.0 + 5
50 Hz to 10 kHz	0.035 + 5	0.075 + 5	0.05 + 5	0.1 + 5	0.1 + 5	0.2 + 5
10 kHz to 40 kHz	–	0.1 + 5	–	0.15 + 5	–	0.3 + 5
10 kHz to 50 kHz (4)	0.075 + 5	–	0.1 + 5	–	0.2 + 5	–
50 kHz to 100 kHz(5)	0.3 + 5	–	0.5 + 5	–	1.0 + 5	–

NOTES: 1. Volt-Hertz product not to exceed 2 x 10^7.
2. Slow Filter must be used below 400 Hz for full accuracy.
3. For high resolution multiply No. of digits by 10.
4. On 1V range add 7 digits.
5. On 1V range add 35 digits.

OPERATING CHARACTERISTICS

INPUT CHARACTERISTICS

Range	Full Scale	Resolution		Impedance
		Normal	High	
1V	2.5V	10 uV	1 uV	1 MΩ, <100 pF
10V	20V	100 uV	10 uV	
100V	160V	1 mV	100 uV	
1000V	1000V	10 mV	1 mV	

Maximum Input—1000V rms or 2 x 10^7 volt-hertz product, whichever is less.

COMMON MODE NOISE REJECTION (100Ω Unbalance)

> 120 dB, dc to 60 Hz

TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)

30 Hz to 50 kHz ± (30 ppm/reading ± 0.5 digit)/°C
50 kHz to 100 kHz ± (100 ppm/reading ± 1 digit)/°C

SETTLING TIME (To Within 0.05%)

100 ms, Fast Filter
500 ms, Slow Filter

DIGITIZING TIME

Same as dc volts

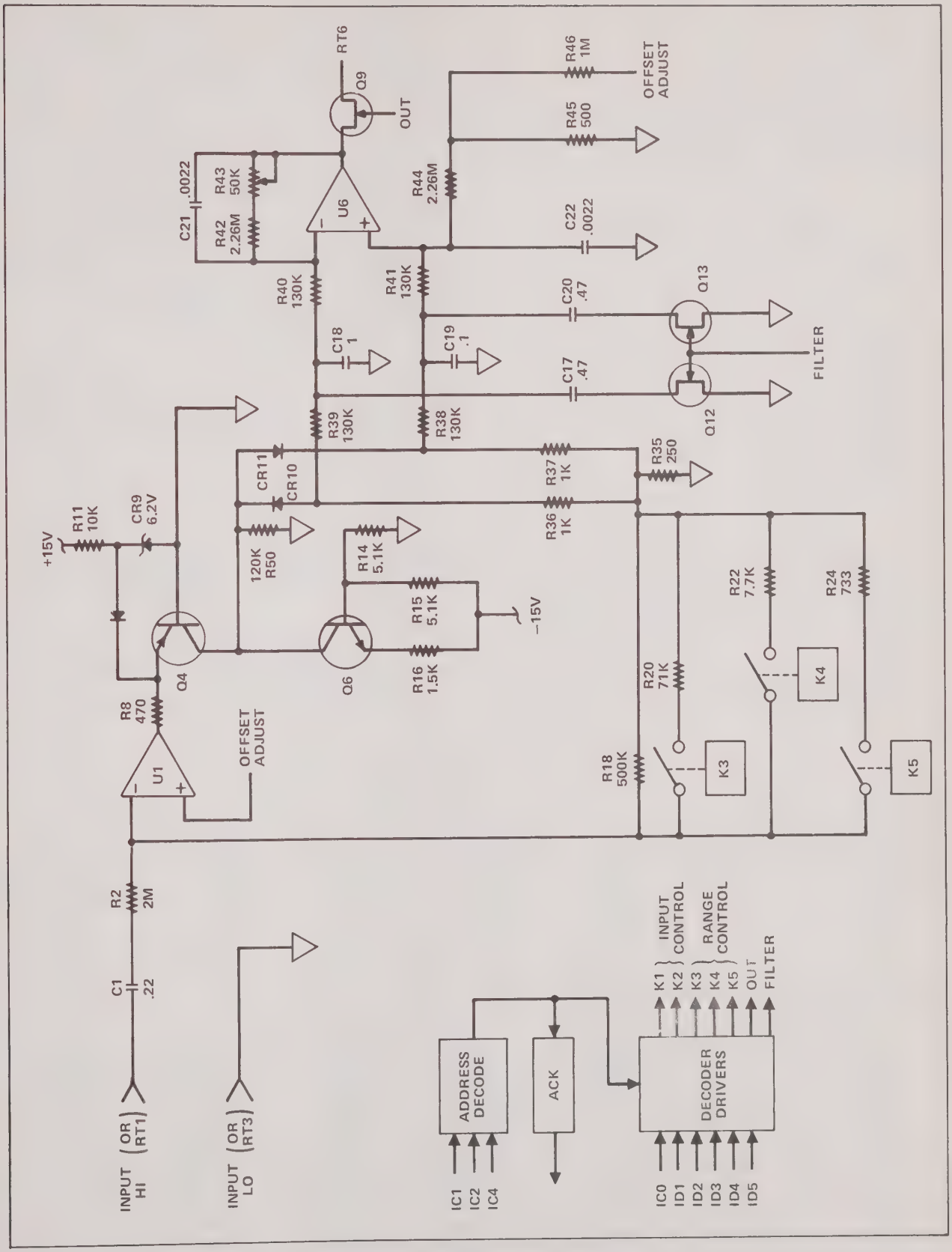


Figure 601-1. AC/DC Converter (Averaging)

601-15. MAINTENANCE

601-16. Performance Test

601-17. Sequentially apply the inputs listed in Table 601-2, ensuring that the reading is between the limits specified.

Table 601-2. Performance Test

Input Freq	Voltage	8500 Reading	
		Low	High
10 kHz	1 V	0.99945	1.00055
50 kHz	1 V	0.99895	1.00105
10 kHz	10 V	9.9945	10.0055
50 kHz	10 V	9.9895	10.0105
10 kHz	100 V	99.945	100.055
50 kHz	100 V	99.895	100.105
10 kHz	1000 V	998.95	1001.05

601-18. Calibration

601-19. Use the DC portion of the instrument to adjust the AC balance of the AC/DC Converter using the following procedure.

1. Select DC Volts, 100 mV range, and slow filtering (FILTER indicator illuminated).
2. Connect TP1 on the AC/DC Converter to the Input HI terminal.
3. Adjust R17 (AC Balance) for a reading of 0 ± 20 μV.
4. Remove the connection between TP1 and Input HI.

601-20. Select AC Volts and manually select the 1000V range. Connect the AC Calibrator to the instrument. Sequentially apply the inputs listed in Table 601-3, making adjustments as required to the nominal value. Those inputs for which no adjustment is listed are to verify that the Averaging Converter is within tolerance.

601-21. Troubleshooting

601-22. Table 601-4 contains a procedure to ensure the problem actually is in the AC Converter. Figure 601-2 contains symptom analysis of the AC Converter and address and data information.

601-23. PARTS LIST

601-24. Table 601-5 contains a parts breakdown for the AC/DC Converter (Averaging). Refer to Section 5 of this manual for ordering and use code information.

⊗ CAUTION

Indicated devices are subject to damage by static discharge.

Table 601-3. Calibration Chart

Input			Reading			Adjust
Range	Voltage	Frequency	Minimum	Nominal	Maximum	
1000V	500	500 Hz	499.93	500.00	500.07	R43
1000V	500	60 kHz	499.92	500.00	500.08	C23
1000V	1	500 Hz	0.99	1.00	1.01	R47
1000V	1	100 kHz	0.97	0.98	0.98	C16
1V	1	500 Hz	0.99993	1.00000	1.00007	R19
1V	1	60 kHz	0.99975	1.00000	0.99990	C8
Repeat the previous steps until no adjustments are required.						
10V	10	500 Hz	9.9993	10.0000	10.0007	R21
10V	10	60 kHz	9.9991	10.0000	10.0009	C10
100V	100	500 Hz	99.993	100.000	100.007	R23
100V	100	60 kHz	99.991	100.000	100.009	C25
100V	100	10 kHz	99.975	100.000	100.025	
10V	19	30 Hz	18.9615	19.0000	19.0385	
10V	19	100 kHz	18.9520	19.0000	19.0480	
1V	1.9	100 kHz	1.89520	1.90000	1.90480	
1V	1.9	10 kHz	1.89520	1.90000	1.90050	
1V	.1	500 Hz	0.09995	0.10000	0.10005	
1000V	1000	20 kHz	999.50	1000.00	1000.50	
1V	5 0.025	50 kHz	0.02492	0.02500	0.2508	
1V	0.025	100 kHz	0.02465	0.02500	0.02535	

Table 601-4. AC Converter Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do the DC Performance Test (Section 4).		
2	Is DC Volts within tolerance?	3	Section 4
3	Is the Calibration Memory module installed?	4	6
4	Remove the Calibration Memory module. Is AC OK?	5	6
5	Bad Calibration Memory. Go to Section 604.		
6	Is Isolator installed?	7	10
7	Replace Isolator with Bus Interconnect/Monitor pcb.		
8	Is AC OK?	9	10
9	Bad Isolator. Go to Section 608.		
10	Remove DC Signal Conditioner. Is AC OK?	11	12
11	DC Signal Conditioner interfering with AC. The problem in the DC Signal Conditioner is one of the following: 1. Digital Logic Bad, 2. K1 or K2 shorted, 3. Q6, Q7, Q8 Bad.		
12	Install Bus Interconnect/Monitor if not already installed.		
13	Check power supply voltages as follows: VA1 = +14.25 to 15.75V VA2 = −14.25 to −15.75V VA3 = +29 to 32V VA4 = −29 to −32V Vcc = −15V, Vss = −20V } Difference = 4.9 to 5.2		
14	Are the supply voltages OK?	15	Section 4
15	Go to Figure 601-2.		

Figure 601-2. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
Noisy Reading	U1, U6
Single range bad	Digital logic, range relay
All ranges bad	U1, U6
Reading out of tolerance	Range relay, U1
Overrange	U6
High frequency bad	U6
No Output	Q9, Q10, Q11, U6, U1, K1, K2
Interfering with DC or Ohms reading	K1 shorted, Q9 leaky
Address: IC 4, 2, 1 high	
Data: ID0 = 1, ID1 = 0	AC Voltage Input Terminals
ID0 = 0, ID1 = 1	AC Current, RT1 and RT3
ID2 = 0	Filter on
ID3 = 0	10V range
ID4 = 0	100V range
ID5 = 0	1000V range
ID5, 4, 3 = 1	1V range

If U1, Q4, Q6, R51, R52, CR10, or CR11 are replaced it may be necessary to change the value of R51 or R52 to correct offset error. Use the following procedure.

1. Remove R51 or R52, whichever is installed.
2. Connect test DMM Hi to TP1, Lo to TP2.
3. With R17 fully CW, the reading should be more than +100 μV.
4. If not, center R17 and select a resistor value from the following table which has the closest corresponding offset voltage. For negative readings, install the resistor as R52. For positive readings, install the resistor as R51.

OFFSET	RESISTOR	J.F. PART #
.25 mV	2.7 MΩ	193490
.5	1.5M	182857
.75	910K	285338
1.0	680K	188433
1.25	560K	220533
1.5	470K	188441
1.75	390K	193383
2.0	360K	234690
2.25	300K	234682
2.5	270K	220061
2.75	240K	218016
3.0–3.25	220K	160937
3.5	200K	248781

Table 601-5. AC/DC Converter (Averaging) Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Ⓧ	**AC/DC CONVERTER (AVG) ASSEMBLY Figure: 601-3**						
C1	Cap, film, 0.22 uF ±20%, 1200V	268904	84411	JF-65	1		
C5	Cap, mica, 33 pF ±5%, 500V	160317	72136	DM15E330J	1		
C6, C14, C15, C26 thru C30	Cap, Ta, 5.6 uF ±20%, 25V	368969	56289	196D565X0025 KA1	8		
C7	Cap, cer, 1 pF ±0.25%, 100V	436477	80031	2222-638-03108	1		
C8, C23	Cap, var, 0.25 –1.5 pF, 2000V	273151	74970	273-0001-002	2	1	
C9, C12	Cap, mica, 15 pF ±2%, 500V	335612	72136	DM15C150G	2		
C10	Cap, var, 0.8 –10 pF, 200V	229930	91293	JMC5201	1	1	
C11	Cap, mica, 150 pF ±1%, 500V	226134	72136	DM15F151F	1		
C13	Cap, mica, 1800 pF ±2%, 500V	447441	72136	DM19F182G	1		
C16, C25	Cap, var, cer, 1.7 –10 pF, 250V	375238	52769	GKC10000	2	1	
C17, C20	Cap, polyester, 0.47 uF ±10%, 100V	369124	89536	369124	2		
C18, C19	Cap, polyester, 0.10 uF ±10%, 100V	393439	89536	393439	2		
C21, C22	Cap, film, 0.0022 uF ±10%, 50V	313239	06001	75F1R5A322	2		
C24	Cap, mica, 68 pF ±5%, 500V	148510	72136	DM15F680J	1		
C31, C32	Cap, Ta, 22 uF ±20%, 15V	423012	56289	196D226X0015 KA1	2		
C33	Cap, mica, 10 pF ±2%, 500V	335638	72136	DM15C100G	1		
CR1, CR2, CR5 thru CR8	Diode, Hi-speed, switching	203323	07910	1N4448	6	2	
CR3, CR4, CR10, CR11	Diode, Si, lo-cap, lo-leak	348177	07263	FD7223	4	1	

CHECK ERRATA

CHANGE # 24

Table 601-5. AC/DC Converter (Averaging) Assembly (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR9, CR12	Diode, zen, uncompn	325811	07910	1N753A	2	1	
K1, K2	Relay, coil, 6V	272070	71707	UD-6-P	2		
	Foil (use on K1, K2)	313833	89536	313833	2		
	Switch, dry reed (use on K1, K2)	284091	95348	MR138	2		
	Switch, dry reed (use on K1, K2)	414300	95348	MR5830-7	2		
K3, K4, K5	Relay, dry reed	357566	71707	UF40069	3		
Q2, Q6, Q10, Q14	Xstr, Si, NPN	218396	04713	2N3904	4	1	
Q3	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
Q4, Q11	Xstr, Si, PNP	195974	04713	2N3906	2	1	
Q5, Q7	Xstr, Si, NPN	218081	89536	218081	2	1	
Q8	Xstr, FET, N-channel	352112	89536	352112	1	1	
Q9	Xstr, FET, N-channel	393314	89536	393314	1	1	
Q12, Q13	Xstr, FET, N-channel	343830	89536	343830	2	1	
R2	Res, mf, 2M ±0.5%, 1W	354894	89536	354894	1		
R3	Res, comp, 120k ±5%, 1/4W	193458	01121	CB1245	1		
R8	Res, comp, 470 ±5%, 1/4W	147983	01121	CB4715	1		
R9	Res, mf, 49.9 ±1%, 1/8W	305896	91637	MFF1-849R9F	1		
R10	Res, mf, 1M ±1%, 1/8W	268797	91637	MFF1-81004F	1		
R11, R12, R25	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	3		
R13, R26, R33, R34	Res, comp, 47k ±5%, 1/4W	148163	01121	CB4735	4		
R14, R15	Res, comp, 5.1k ±5%, 1/4W	193342	01121	CB5125	2		
R16	Res, comp, 1.5k ±5%, 1/4W	148031	01121	CB1525	1		

CHECK ERRATA

Table 601-5. AC/DC Converter (Averaging) Assembly (Continued) CHANGE # 24

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R17, R47	Res, var, cermet, 100k ±10%, 1/2W	288308	89536	288308	2	1	
R18	Res, mf, 500.85k ±0.1%, 1/8W	424614	91637	MFF1-8500851B	1		
R19	Res, var, cermet, 2k ±10%, 1/2W	285163	89536	285163	1	1	
R20	Res, mf, 71.320k ±0.1%, 1/8W	424515	91637	MFF1-871321B	1		
R21	Res, var, cermet, 500 ± 10%, 1/2W	291120	89536	291120	1	1	
R22	Res, mf, 7.704k ±0.1%, 1/8W	436121	91637	MFF1-87704B	1		
R23	Res, var, cermet, 50 ± 10%, 1/2W	285122	89536	285122	1		
R24	Res, mf, 733.9 ± 0.1%, 1/8W	460212	91637	MFF1-8733R9B	1		
R27	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R28	Res, comp, 22k ±5%, 1/4W	148130	01121	CB2235	1		
R29	Res, comp, 15k ±5%, 1/4W	148114	01121	CB1535	1		
R30	Res, comp, 8.2k ±5%, 1/4W	160796	01121	CB8225	1		
R31, R32, R48	Res, comp, 51k ±5%, 1/4W	193334	01121	CB5135	3		
R35 thru R42, R44, R45, R46	Res, Matched Set	441873	89536	441873	1	1	
R43	Res, var, cermet, 50k ±10%, 1/2W	288290	89536	288290	1	1	
R49	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	1		
R50	Res, comp, 120k ±5%, 1/4W	193458	01121	CB1245	1		
R51, R52	Res, selected						
R53, R54	Res, comp, 100 ±5%, 1/4W	147926	01121	CB1015	2		
U1	IC, Lin, Op Amp	429951	12040	LF357AH	1	1	
U2	⊗ IC, Dgtl, C-MOS, hex, "D" flip-flop	404509	12040	MM74C174N	1	1	
U3	⊗ IC, Dgtl, C-MOS, quad, 2-input, NAND gates	375147	02735	CD4023AE	1	1	
U4	⊗ IC, Dgtl, C-MOS, hex inverter/buffer	381848	02735	CD4049AE	1	1	
U5	IC, TTL, hex, inverter, buffer/driver	288605	01295	SN7416N	1	1	

Table 601-5. AC/DC Converter (Averaging) Assembly (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U6	IC, Lin, Op Amp	288928	12040	LM308AH	1	1	
	Case half	402990	89536	402990	2		
	Cover, Module Case	402974	89536	402974	1		
	Decal	413385	89536	413385	1		
	Guard, cover	411926	89536	411926	1		
	Guard, front	383356	89536	383356	1		
	Guard, rear	383364	89536	383364	1		
	Insulator, AVG Shield	437913	89536	437913	1		
	Shield, AVG Converter	437905	89536	437905	1		
	Shield, AVG Converter, rear	437897	89536	437897	1		
	Socket, component lead	343285	00779	2-331272-6	4		

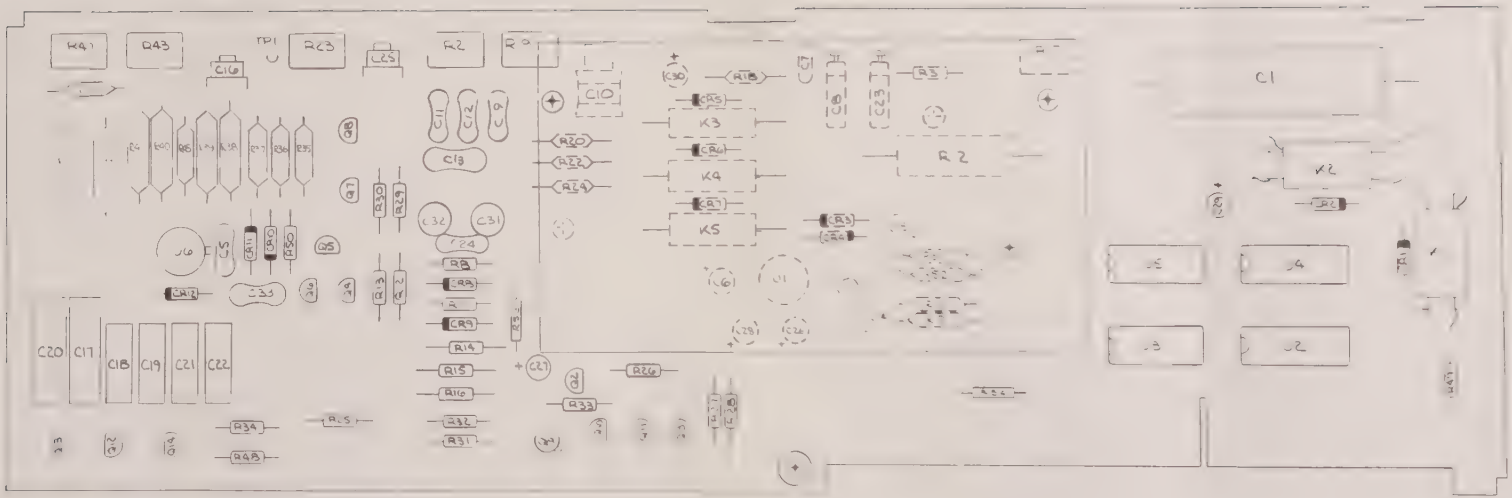
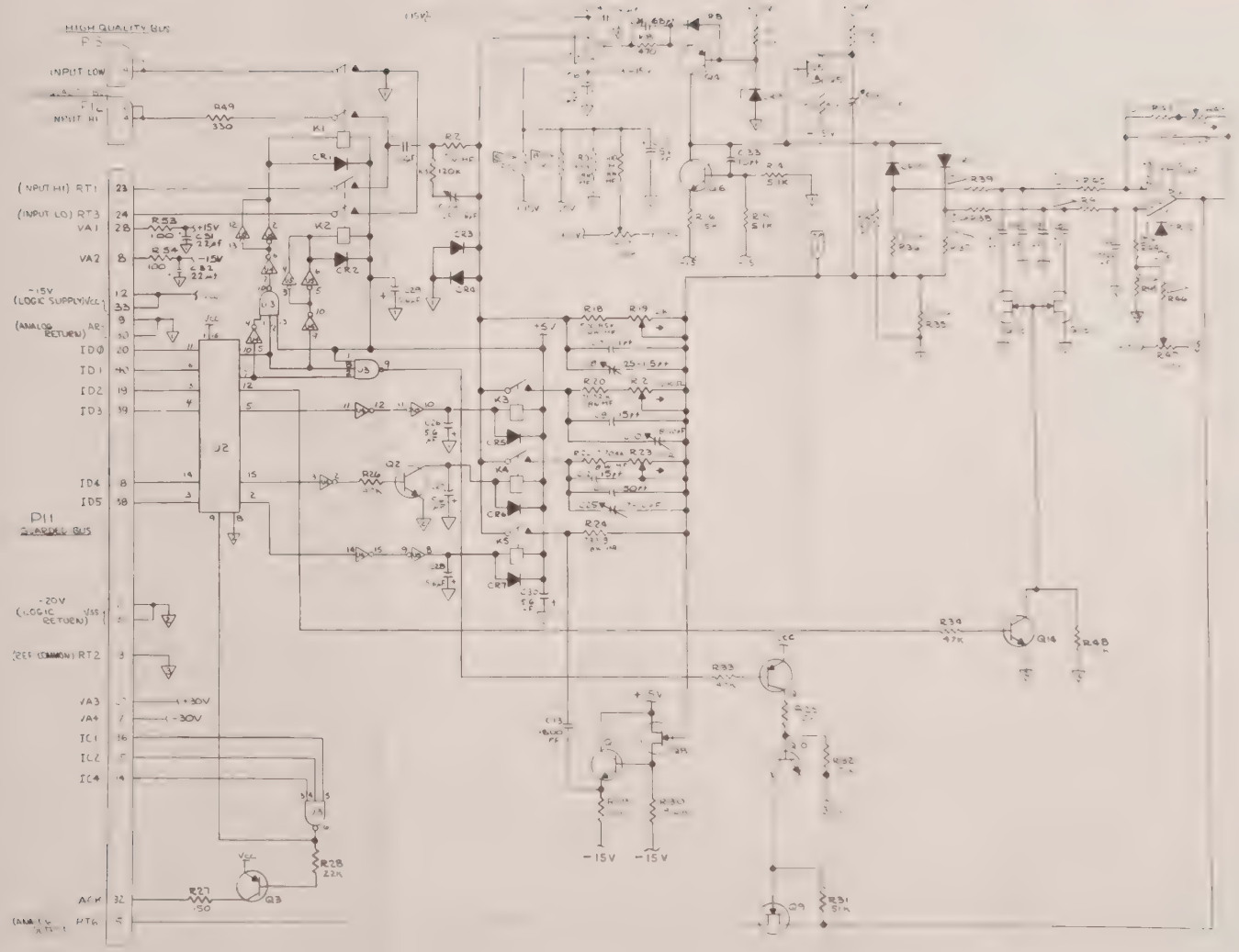


Figure 601-3. AC/DC Converter (Avg) Assembly (M.I.S. 1701)



NOTE 1: UNLESS OTHERWISE SPECIFIED

REF DES: A4, CP12, K5, C33, R54.

REF DES NO'S NOT USED: R1, 4, 5, 6 & 7; C.2, 3 & 4

MATCHED RESISTOR SET

FACTORY SELECTED PARTS

Figure 601-4. AC/DC Converter (Avg) (M.I.S.1101)

Change/Errata Information

Issue No: 1 8/78

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual in the order given.

MANUAL

Title: OPTION –02 OHMS CONVERTER
Print Date: (8500 Series) (Part Number 469700)
Rev and Date:

C/E PAGE EFFECTIVITY

Page No.	Print Date
1	8/78

ERRATA #1

In the explanation of two-wire ohms zeroing (paragraph 602-9), add the following sentence immediately prior "Depress the V DC/OHMS ZERO switch.": "Depress the STORE switch."

Under the CALIBRATION procedure, 602-22, change steps 4, 6 and 9 to read:

"4. Short the INPUT terminals as illustrated in Figure 602-6. Use the terminal shorting straps (provided with the instrument) or equivalent."

"6. Select the 10 ohm range on the DMM."

"9. Remove the shorting straps and make four-wire ohms measurement connections to the INPUT terminals. Select the 1 Mohm range and connect the input leads to a 4 Mohm standard resistor. (Standard resistors are listed in Table 4-1 of the Instruction Manual.)"

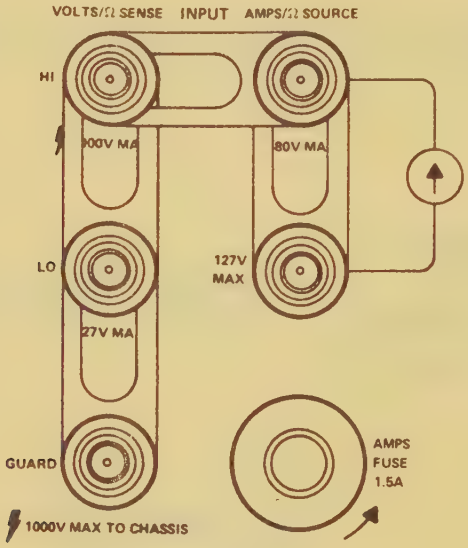


Figure 602-6. Input Terminal Shorting

ERRATA #2

Under reference designator U1, change Mfg. Part No. from: CD4011AE to: CD4023AE

CHANGE #1–11322

In Table 602-9 (Parts List), make the following changes:
Under reference designator Q9, change the Fluke Stock No. and the Mfg. Part No. from: 287623 to: 476309.

Change/Errata Information

Issue No: 1 8/78

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual in the order given.

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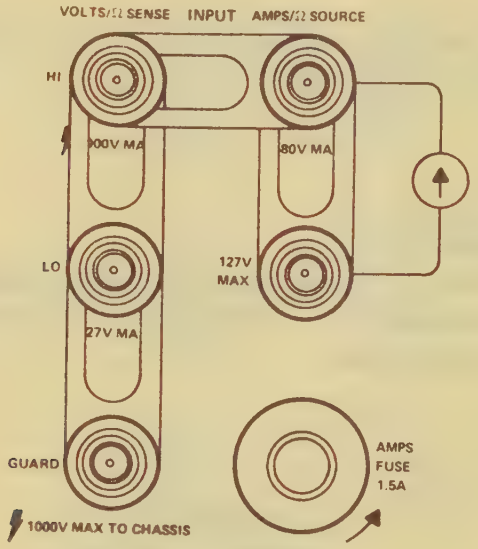

Figure 602-6. Input Terminal Shorting

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Option —02
Ohms Converter

602-1. INTRODUCTION

602-2. Installation of the Ohms Converter provides precision resistance measurement capability ranging from 100 μΩ to 262 MΩ. Both two-terminal and four-terminal measurements may be made.

602-3. SPECIFICATIONS

602-4. Table 602-1 lists the specifications of the Ohms Converter.

602-5. INSTALLATION

602-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing and removing modules. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

602-7. OPERATING NOTES

602-8. Operation of the front panel controls with the Ohms Converter Option installed is the same as described in Section 2 of this manual. Eight ranges are available for resistance measurements: 10, 100, 1K, 10K, 100K, 1M, 10M, and 100M. Ranges may be either manually or automatically selected. Four-wire measurements may be made up through the 100K range. In the 1M, 10M, and 100M ranges only two-wire measurements may be made, as lead resistance will not affect accuracy. However, the four-wire connections may still be used if desired. Sense HI to Source HI and Sense LO to Source LO connections must be made either with the shorting links provided (two-wire mode) or at the resistance to be measured (four-wire mode). Figure 602-1 shows possible connections for both the two-wire and four-wire modes.

Table 602-1. Ohms Converter Specifications

ACCURACY

(Refer to the specifications table in section 1 for required environmental conditions)

Range	NORMAL RESOLUTION Accuracy ± (% of Input + No. of Digits)			HIGH RESOLUTION Accuracy ± (% of Input + No. of Digits		
	24 Hours	90 Days	1 Year	24 Hours	90 Days	1 Year
10Ω	0.003 + 20	0.005 + 20	0.01 + 20	—	—	—
100Ω	0.002 + 2	0.003 + 2	0.006 + 2	0.002 + 14	0.003 + 14	0.006 + 14
1 kΩ	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
10kΩ	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
100 kΩ	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
1 MΩ	0.002 + 1	0.003 + 1	0.006 + 1	0.002 + 8	0.003 + 8	0.006 + 8
10 MΩ	0.01 + 1	0.02 + 1	0.04 + 1	0.01 + 8	0. 02 + 8	0.004 + 8
100 MΩ	0.03 + 1	0.05 + 1	0.1 + 1	0.03 + 8	0.05 + 8	0.1 + 8

Table 602-1. Ohms Converter Specifications (Continued)

OPERATING CHARACTERISTICS

Range	Full Scale	Current Through Unknown	Normal Resolution		High Resolution	
			Resolution	Temperature Coefficient* ± (ppm/rdg + No. of Digits)/°C	Resolution	Temperature Coefficient* ± (ppm/rdg + No. of Digits)/°C
10Ω	31.25Ω	10 mA	100 uΩ	8 + 1.5	–	–
100Ω	250Ω	10 mA	1 mΩ	7 + 0.2	100 uΩ	7 + 2
1 kΩ	2 kΩ	1.25 mA	10 mΩ	7 + 0.2	1 mΩ	7 + 2
10 kΩ	32 kΩ	78 uA	100 mΩ	7 + 0.2	10 mΩ	7 + 2
100 kΩ	256 kΩ	9.8 uA	1Ω	7 + 0.2	100 mΩ	7 + 2
1 MΩ	4.096 MΩ	4.9 uA	10Ω	7 + 0.2	1Ω	7 + 2
10 MΩ	32.768 MΩ	0.61 uA	100Ω	30 + 0.2	10Ω	30 + 2
100 MΩ	262.144 MΩ	76 nA	1 kΩ	50 + 0.2	100Ω	50 + 2

*0°C to 18°C and 28°C to 50°C

MAXIMUM LEAD RESISTANCE

Mode	Leads	Range	Maximum Lead Resistance
4-wire	Source	10 – 100Ω	10Ω
4-wire	Source	1 kΩ	100Ω
4-wire	Source	10 kΩ – 100 MΩ	1 kΩ
4-wire	Source	All	1 kΩ
2-wire	Source	All	Less than 0.001% of range unless offset

OPEN CIRCUIT VOLTAGE

Range	Voltage	Configuration
10Ω to 100 kΩ	7 volts max	4 Terminal
1 MΩ to 100 MΩ	25 volts max	2 Terminal

OVERLOAD

± 400V dc to 60 Hz, or 560 volts peak ac above 60 Hz maximum continuous on any range with no damage.

SETTLING TIME – (To Rated Accuracy)

80 ms, Fast Filter
800 ms, Slow Filter

DIGITIZING TIME

Mode of Operation	Filter	60 Hz		50 Hz	
		Approx. Rdg. Rate	Digitizing Time	Approx. Rdg. Rate	Digitizing Time
Bench	Fast	4 rdg/s	250 ms	3-1/3 rdg/s	300 ms
	Fast	1-1/2 rdg/s	700 ms	1-1/4 rdg/s	800 ms
	Slow	1-1/4 rdg/s	800 ms	1 rdg	1000 ms
	Slow	5/6 rdg	1200 ms	3/4 rdg	1450 ms
Remote	Fast	4 samples/rdg	145 ms	4 samples/rdg	175 ms
	Slow	4 samples/rdg	700 ms	4 samples/rdg	840 ms
(Subtract for fast Ohms)	Fast	–	110 ms	–	–
	Slow	–	560 ms	–	–

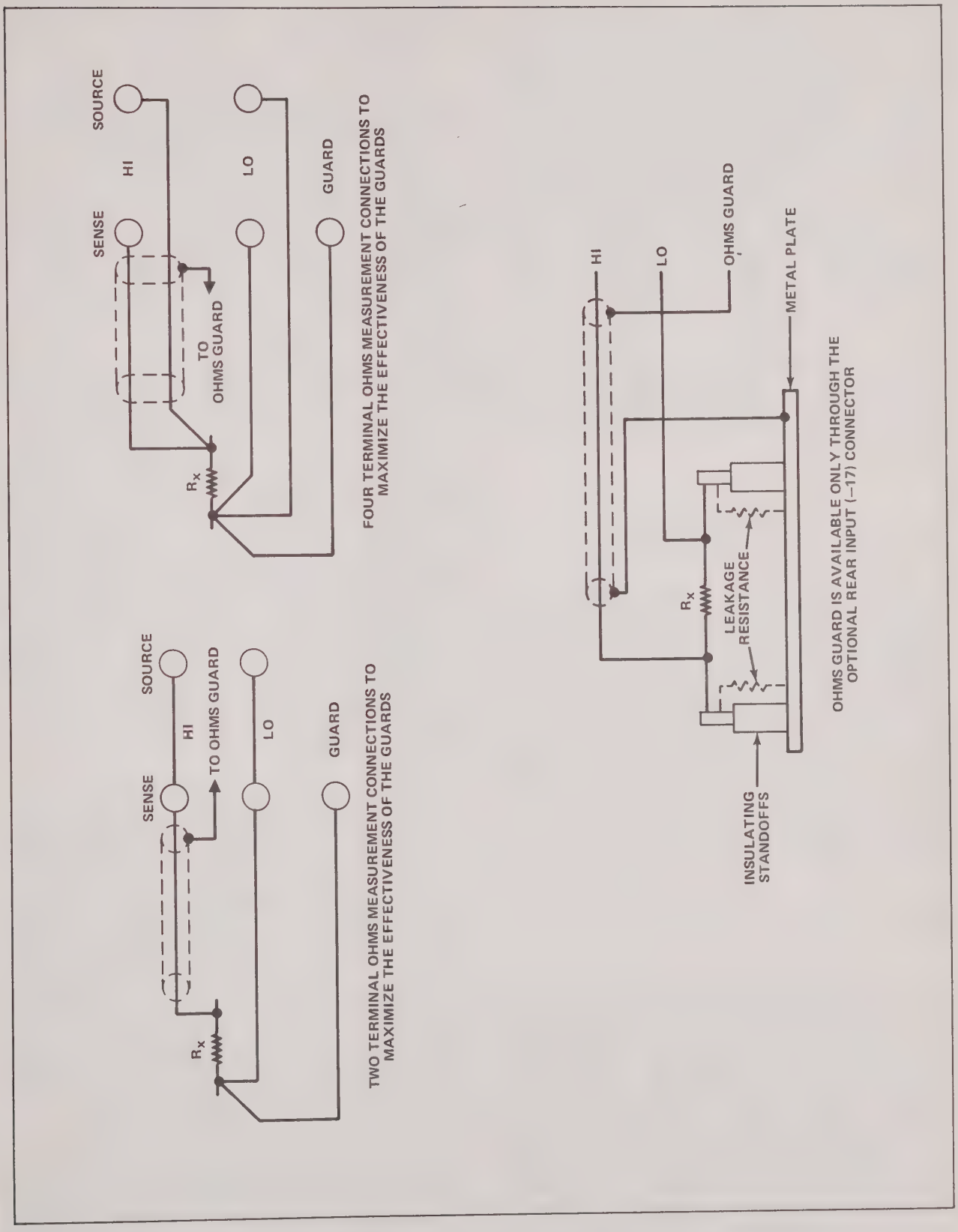


Figure 602.1. Ohms Measurement Connections And Guarding

602-9. For the two-wire ohms mode, the instrument should be zeroed with a good quality short between Sense-Source HI and Sense-Source LO. Select either autoranging or the 10Ω range manually. Depress the V DC/Ω ZERO switch. All ranges are now automatically zeroed. Ohms zero cannot be recalled. Depressing the RECALL switch while in Ohms results in a display of ERROR 0, then a return to the program. To compensate for lead resistance use the Offset mode. Short the ends of the leads together. Depress the STORE switch, then the OFFSET switch. This enters the lead resistance value into memory. Depress the OFFSET switch again (OFFSET LED illuminated) to enter the Offset mode in which the value of lead resistance will automatically be subtracted from further readings.

602-10. In the four-wire ohms mode, the instrument should be zeroed by placing a good quality short at the ends of the leads. Depress the V DC/Ω ZERO switch to enter the zero value, which will automatically be subtracted from further readings.

602-11. Guarding

602-12. The ohms guard connection is available only through the optional Rear Input Connection (−17). Figure 602-1 shows optimal use of the guard. Basically the ohms guard is used to minimize leakage resistance between the HI and LO leads which would appear as shunt resistance across high R_X values. In some high-resistance measurement set-ups, leakage resistance in or on the surface of insulating materials may provide enough shunt resistance to degrade the accuracy of the measurement. Figure 602-1 illustrates one such case. Connecting the ohms guard to the metal plate on which the standoffs are mounted reduces the effect of leakage resistance through or on the standoffs.

602-13. THEORY OF OPERATION

602-14. The function of the Ohms Converter is to produce a current through an unknown resistance such that the voltage across the unknown is proportional to the value of resistance. This is accomplished by configuring the unknown resistance, R_X, as the feedback element of an operational amplifier. A reference voltage, V_{REF}, is applied through a reference resistor, R_{REF}, to the summing node of the amplifier. By definition of an ideal operational amplifier, the current through R_X is the same current flowing through R_{REF} (the summing node represents a virtual ground). Figure 602-2 is a simplified schematic of the Ohms Converter and contains an illustration of the derivation of the formula for R_X. The current flowing through R_{REF} equals $(V_1 - V_2)/R_{REF}$. Using the expression for current to obtain the value of R_X:

$$R_X = R_{REF} \left(\frac{V_O}{V_1 - V_2}\right).$$

The Ohms Converter multiplexes the voltages which, after being routed through the DC Signal Conditioner and the Filter module, are measured by the A/D Converter.

602-15. The current reference for the Ohms Converter is derived from the −7V reference (RT4) from the A/D Converter. U4 is an inverting amplifier with two possible feedback paths to produce either approximately +2.3V or +18.5V as V_1. U4 drives Q8 with Q8 serving as a larger current source than is available from U4. R41, R45, and R56 are the reference resistors, each having an adjustment.

602-16. R_X is the feedback element for the operational amplifier composed of Q9 and U5. U5 drives Q37 which serves as a higher current source. This arrangement also allows a larger output voltage swing. Note that Q9 and U5 are configured as an inverter, yet the output of U5 is a positive voltage. Q37 draws its emitter current through R48 and R49 from the −30V supply with CR18 and CR13 ensuring that Q37 need not be in a state of saturation. SOURCE voltages out are negative voltages at SOURCE LO with respect to circuit common. In the 100M range, the voltage applied to R41 is divided by 8. However, the unattenuated V_{REF} is measured. The factor of 8 is preserved by assigning R_{REF} the value of 8 x R41 (32.768 MΩ) in the equation. As the Ohms Converter downranges, R41 remains enabled so lower R_{REF} values are actually parallel combitions. V_2 is not measured in the three highest ranges (1M, 10M, 100M) since lead resistance will not be large enough to affect accuracy.

602-17. Extensive overvoltage protection has been provided for the Ohms Converter. Refer to the full schematic. Voltages appearing on the SENSE or SOURCE HI terminals in excess of +28V or −3V (with respect to circuit common) are clamped to ground by Q14, CR7, Q10, and Q39. U5 is configured as a voltage comparator biased by CR19 and R14. The clamping action of Q14 or Q10 causes a voltage on the input Lo line which triggers comparator U5 through Q11 or Q15. In either case the output at U5 pin 7 toggles to its maximum positive level, clocking U3 while placing a high on the ID3 line. This opens relay K1 and removes the input voltages from the module. The high from U5 also inhibits the ACK logic so an Error 4 will be displayed. CR13 and CR14 at the output of Q9, U5 are high voltage blocking diodes. E1 is a spark gap preventing voltages in excess of 400V between the guard shield and circuit common.

602-18. The Ohms Converter is addressed by IC1, 2, 3 high, and must be addressed for each sample voltage. Samples are multiplexed out at the rate of one every four msec. This requires the fastest response time in the DC Signal Conditioner of any measurement mode.

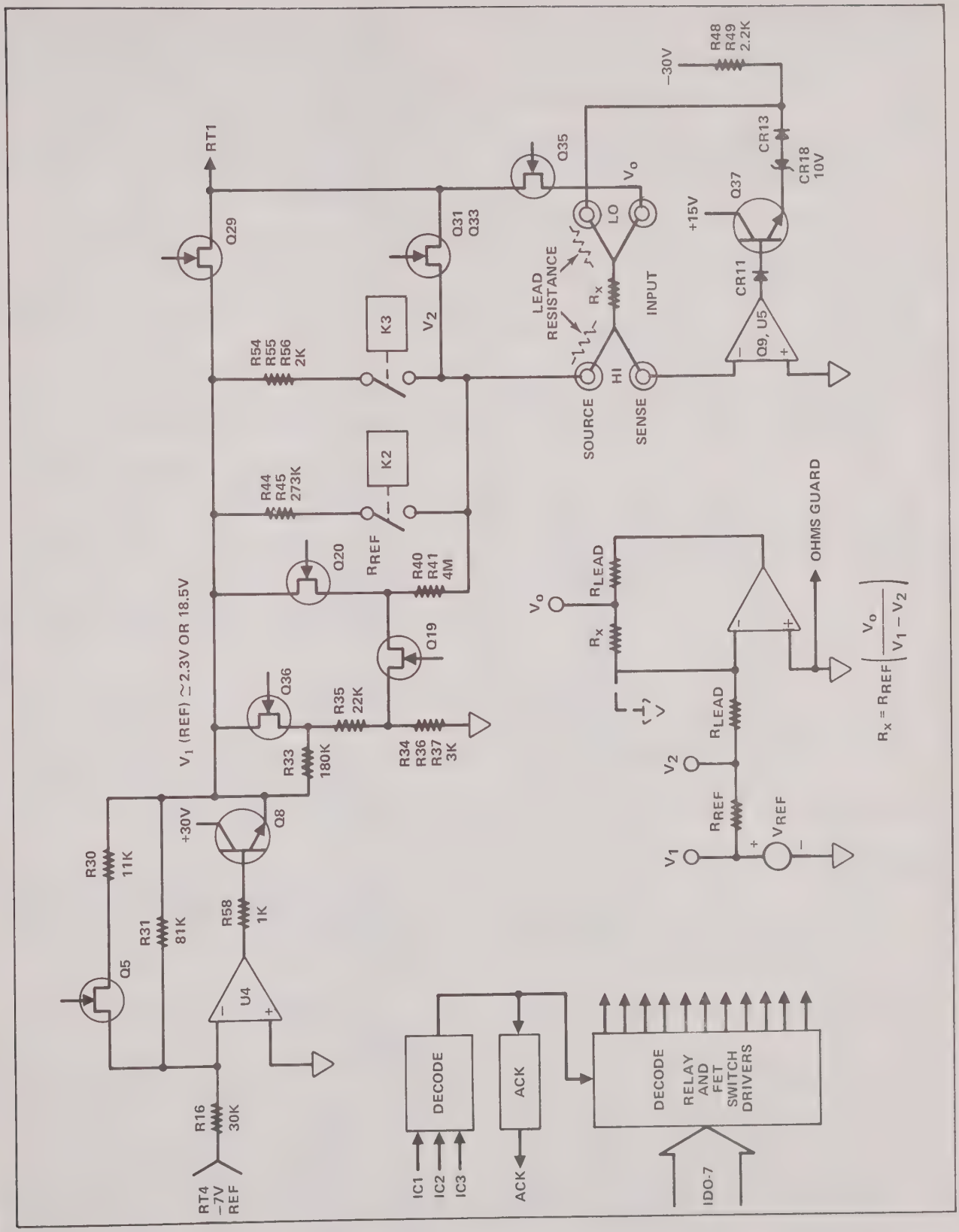


Figure 602-2. Ohms Converter

602-19. MAINTENANCE

602-20. Performance Test

602-21. Test the Ohms function using the following procedure:

1. Connect test leads to the instrument in the four-wire configuration.
2. Select the Ohms function and Autoranging.
3. Short the HI and LO Ω SOURCE leads, short the HI and LO SENSE leads; then connect the two pairs of shorted leads together.
4. Zero the instrument by depressing the STORE switch, then the V DC/Ω ZERO switch.
5. Remove the shorts and sequentially connect the standard resistors in Table 602-2. The 8500A readings should fall within the limits specified.

Table 602-2. Performance Test

Standard Resistor	8500A Reading	
	Low (exponent)	High (exponent)
10	9.9975	10.0025
100	99.995	100.005
1K	.99996 (+3)	1.00004 (+3)
10K	9.9996 (+3)	10.0004 (+3)
100K	99.996 (+3)	100.004 (+3)
1M	.99996 (+6)	1.00004 (+6)
10M	9.9979 (+6)	10.0021 (+6)
100M	99.949 (+6)	100.051 (+6)

602-22. Calibration

602-23. Use the following procedure to calibrate the Ohms Converter:

1. Remove power and remove the Calibration Memory if installed.
2. Reapply power and allow a one hour warm-up.
3. Ensure that the dc Volts accuracy is within tolerance.
4. Connect test leads to the instrument in the four-wire configuration.
5. Use manual range selection to prevent range changes while testing at the range extremities.
6. Select the 10Ω range on the 8500A and short the four-terminal input leads for a zero input.
7. Adjust R24 for a reading between –0.0003 and +0.0003.
8. Step through the other seven ranges, checking that the reading is 0 ± 1 digit on all seven ranges.
9. Select the 1 MΩ range and connect the input leads to a 4 MΩ standard resistor.
10. Adjust R40 for a reading between 3.99998 (+6) and 4.00002 (+6).
11. Select the 100 MΩ range and connect the input leads to a 100 MΩ standard resistor.
12. Adjust R37 for a reading between 99.995 (+6) and 100.005 (+6).
13. Select the 100 kΩ range and connect the input leads to a 250 kΩ standard resistor.
14. Adjust R44 for a reading between 249.998 (+3) and 250.002 (+3).
15. Select the 1 kΩ range and connect the input leads to a 1.9 kΩ standard resistor.
16. Adjust R54 for a reading between 1.89998 (+3) and 1.90002 (+3).
17. Select the 10Ω range and short the four-terminal leads for a zero input.
18. Perform the Ohms Zero procedure found in the operating instructions, ensuring the result is 0.0000 ± 1 digit.
19. Perform the tests in Table 602-3. There are no adjustments for the readings, if any reading exceeds the listed tolerance the module is not acceptable.

Table 602-3. Calibration Tests

Resistance Standard	Readings		
	Minimum	Nominal	Maximum
10	9.9989	10.0000	10.0011
100	99.997	100.000	100.003
1k	0.99997 (+3)	1.00000 (+3)	1.00003 (+3)
10k	9.9997 (+3)	10.0000 (+3)	10.0003 (+3)
100k	99.997 (+3)	100.000 (+3)	100.003 (+3)
1M	0.99997 (+6)	1.00000 (+6)	1.00003 (+6)
10M	9.9989 (+6)	10.0000 (+6)	10.0011 (+6)
100M	99.969 (+6)	100.000 (+6)	100.031 (+6)

602-24. TROUBLESHOOTING

602-25. Troubleshooting procedures for the Ohms Converter follow the format used for the mainframe instrument. Table 602-4, Failure Isolation, assures that the problem is in the Ohms Converter. Table 602-5 lists symptoms and possible failures in the order of probability. Figure 602-3 shows timing relationships, while Tables 602-6 through 602-8 give additional troubleshooting information.

602-26. Always remove power before removing or installing modules. RT1 is available only in the front four option slots and not in the Isolator or Interconnect slot.

602-27. PARTS LIST

602-28. Table 602-9 is a parts breakdown for the Ohms Converter. Refer to Section 5 of this manual for ordering and use code information.

Table 602-4. Failure Isolation

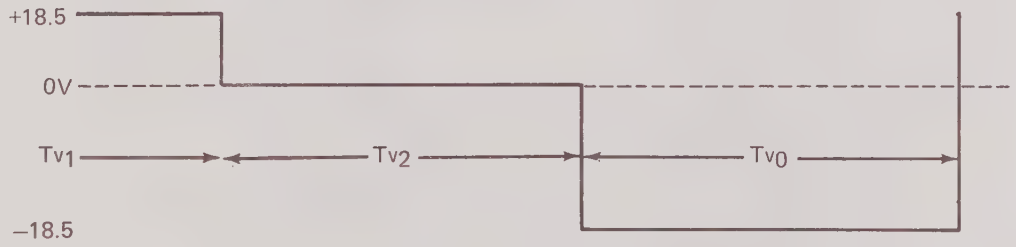
STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Perform DC Volts test (Section 4). Is DC Volts within tolerance?	2	Section 4
2	Perform Ohms test. Is Ohms within tolerance?	Section 4	3
3	Remove all optional modules except Isolator and Ohms converter.		
4	Is Ohms now within tolerance?	5	6
5	An optional module is affecting Ohms. Replace one at a time until Ohms goes bad. Last one in is faulty – go to appropriate portion of Section 6.		
6	Is Isolator installed?	7	9
7	Remove Isolator. Insert Jumper/Monitor pcb. Is Ohms within tolerance:	8	9
8	Bad Isolator. Go to Subsection 608.		
9	Check power supply voltages as follows. Test DMM LO on AR (analog return). VA1 = +14.25 to 15.75V VA2 = –14.25 to –15.75V VA3 = +29 to 32V VA4 = –29 to –32V Vcc = –15V, Vss = –20V } Difference = 4.9 to 5.2 RT4 = –6.993 to –7.007		
10	Are the supply voltages within tolerance?	11	Section 4
11	The problem is probably in the Ohms board. However, the DC Signal Conditioner may contribute errors if the slew rates of the amplifiers are not fast enough. Go to Table 602-5.		

Table 602-5. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
No Ohms Readings (V_0)	U5, Q9, Q35, Digital Logic
(V_1)	U4, Q8, Q29 Digital Logic & Drivers
Ohms Zero Drift	U5, Q9
10K – 100K Ranges Bad	Q32, Q33, Digital
10 – 100 – 1K Ranges Bad	Q30, Q31, Digital
10M Full Scale Low	Q20, Q22
No ACK	U5, Q14, Q11, Q38
All Ranges Out of Tolerance	Q37, U5
100M Noisy, 30M High	Q10, K3 Shorted
1K, 100K, 10M, 100M Ranges Bad	Q5, Q4
100M Range Bad	Q20, Q22, Q19 Leaky
Display Error 4 with no voltage at input	Q14
Noisy at 30M or Full Scale	CR15, CR17, CR4, CR8
Full Scale 1M, 10M, 100M Ranges Out of Tolerance	CR18
DC SIGNAL CONDITIONER	
Slew Rates Bad	Q37, Q38, Q19, U3, U5, U6

Note: If Q9, Q19, U5, R19, R20, R21, R23, R25, or R26 are replaced it is necessary to return the module to the factory (Attn: Parts) for temperature compensation.

Voltages shown are at RT6, (DC Signal Conditioner Output).



Vo is proportional to Rx, Vo for full scale Rx is shown.

Sample Rate	Filter	Tv_1	Tv_2 *	Tv_0
Fast	No	30ms	30ms	200 ms
Fast	Yes	30ms	30ms	650ms
Slow	No	30ms	30ms	600ms
Slow	Yes	30ms	30ms	1060ms

These are approximate times.

*Except Tv_2 for ranges 1M, 10M, 100M is zero. No V_2 is measured for these ranges.

The first reading after a range change or overrange is modified with longer V_1 and V_2 periods.

Figure 602-3. Timing

Table 602-6. Voltage Measurements

Range	Full Scale	V* TP2	R ref	I ref* (Source HI)	V_0* (Range Value)	V_1* (TP2)	V_2 (Offset)
10	31.25	+18.5V	2K	9.3ma	.093V	+18.5	< 100mv
100	250	+18.5V	2K	9.3ma	.93V	+18.5	< 100mv
1000	2000	+2.3V	2K	1.2ma	1.2V	+2.3	< 100mv
10K	32K	+18.5V	256K	72μa	.72V	+18.5	< 100mv
100K	256K	+2.3V	256K	9μa	.9V	+2.3	< 100mv
1M	4.091M	+18.5V	4.091M	4.5μa	4.5V	+18.5	NA
10M	32.728M	+2.3V	4.091M	.56μa	5.6V	+2.3	NA
100M	261.824M	+2.3V/8	4.091M	70na	7V	+2.3	NA

* Approximate values (± 5%)

TP1 is always −7.0V
TP3 Ref common (use for low side of measurements)
TP4 amplifier offset (<10μv properly adjusted)
V_0 is proportional to RX
V_2 will vary some with range change

SCANNER: Voltages will appear on RT1 in order. $V_0 - V_1 - V_2$

Table 602-7. Range Switch Closures

0 = Switch Open

1 = Switch Closed

Chart applies for time the particular voltage is SCANNED. All other times "0" applies.

	K1	K2	K3	Q5	Q19	Q20	V_0 Q29	V_{2a} Q31	V_{2b} Q33	V_1 Q35
10Ω	1	0	1	0	0	1	1	1	0	1
100Ω	1	0	1	0	0	1	1	1	0	1
1KΩ	1	0	1	1	0	1	1	1	0	1
10KΩ	1	1	0	0	0	1	1	0	1	1
100KΩ	1	1	0	1	0	1	1	0	1	1
1MΩ	1	0	0	0	0	1	1	0	0	1
10MΩ	1	0	0	1	0	1	1	0	0	1
100MΩ	1	0	0	1	1	0	1	0	0	1
OHMS	0	0	0	1	0	1	0	0	0	0

Table 602-8. Address and Data Coding

ADDRESS IC1, 2, 3 HIGH									
Range	V	IDϕ	ID1	ID2	ID3	ID4	ID5	ID6	ID7
10	V_ϕ	0	1	1	0	0	1	1	0
	V_1	1	0	1	0	0	1	1	0
	V_2	1	1	0	0	0	1	1	0
100	V_ϕ	0	1	1	0	0	1	1	0
	V_1	1	0	1	0	0	1	1	0
	V_2	1	1	0	0	0	1	1	0
1K	V_ϕ	0	1	1	0	1	1	1	0
	V_1	1	0	1	0	1	1	1	0
	V_2	1	1	0	0	1	1	1	0
10K	V_ϕ	0	1	1	0	0	0	1	1
	V_1	1	0	1	0	0	0	1	1
	V_2	1	1	0	0	0	0	1	1
100K	V_ϕ	0	1	1	0	1	0	1	1
	V_1	1	0	1	0	1	0	1	1
	V_2	1	1	0	0	1	0	1	1
1M	V_ϕ	0	1	1	0	0	1	1	1
	V_1	1	0	1	0	0	1	1	1
10M	V_ϕ	0	1	1	0	1	1	1	1
	V_1	1	0	1	0	1	1	1	1
100M	V_ϕ	0	1	1	0	1	1	0	1
	V_1	1	0	1	0	1	1	0	1
OHMS		1	1	1	1	1	1	1	1

Table 602-9. MIS-4110 Ohms Converter Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	OHMS CONVERTER ASSEMBLY **Figure: 602-4**						
C1 thru C4	Cap, Ta, 6.8 uF ±20%, 35V	363713	56289	196D685X0035 KA1	4		
C5	Cap, cer, 33 pF ±2%, 100V	354852	80031	2222-638-10339	1		
C6, C7	Cap, cer, 1200 pF ±20%, 100V	358283	80031	2222-630-01-122			
C8	Cap, polystryrn, 100 pF ±10%, 500V	446609	89536	446609	1		
C9, C10, C12 thru C15, C19	Cap, cer, 0.01 uF ±20%, 100V	149153	56289	C023B101F103M	7		
C11	Cap, Ta, 22 uF ±20%, 15V	423012	56289	196D226X0015 KA1	1		
C16	Cap, Ta, 5.6 uF ±20%, 25V	368869	56289	196D565X0025 KA1	1		
C17, C21 C23	Cap, cer, 0.22 uF ±20%, 50V	309849	71590	CW30C224K	3		
C18	Cap, Ta, 0.47 uF ±20%, 35V	161349	56289	196D474X0035 HA1	1		
C20	Cap, cer, 0.0022 uF ±10%, 500V	268425	32897	851000Z5R 222K	1		
C22	Cap, Ta, 0.33 uF ±20%, 35V	408690	56289	196D334X0035 HA1	1		
CR1, CR2, CR3, CR11, CR16, CR19, CR20	Diode, Si, Hi-speed switching	203323	07910	1N4448	7	2	
CR4, CR7, CR8, CR13, CR14, CR15, CR17	Diode, Si, rect	428144	01295	1N4006	7	2	

CHECK ERRATA # 6

CHANGE #16

Table 602-9. MIS-4110 Ohms Converter Assembly (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR9, CR18	Diode, zener uncomp	113324	07910	1N961A	2	1	
CR10, CR12	Diode, Si, multipellet	375485	09214	MPD300	2	1	
E1	Surge protector, vol	442723	25088	B1-C145	1		
K1	Relay, armature	~~441261~~ 515429	77342	R40-E0186-1	1		
K2, K3	Relay, dry reed	357582	71707	UF40070	2		
L1	Choke, RF	111542	99800	1537-76	1		
Q1	Xstr, Si, NPN	226290	04713	MPS3640	1	1	
Q2, Q4, Q8, Q13, Q18, Q22, Q23, Q25, Q27, Q28, Q30, Q32, Q34, Q37	Xstr, Si, NPN	218396	04713	2N3904	14	3	
Q3, Q12, Q17, Q21, Q24, Q26, Q38	Xstr, Si, PNP	195974	04713	2N3906	7	2	
Q5, Q19, Q20, Q36	Xstr, FET N-channel	261578	89536	261578	4	1	
Q6, Q7, Q39	Xstr, Si, PNP	168716	07263	S19254	3	1	
Q9	Xstr, FET, dual, N-channel	287623	89536	287623	1	1	
Q10, Q11, Q14, Q15, Q16	Xstr, Si, NPN	203489	09214	11C2322	5	1	
Q29, Q31, Q33, Q35	Xstr, FET, N-channel	393314	89536	393314	2	1	
Q40	Xstr, FET junction, N-channel	288324	89536	288324	1	1	
R1, R3, R10, R11, R42, R59	Res, comp, 20k ±5%, 1/4W	221614	01121	CB2035	6		

Table 602-9. MIS-4110 Ohms Converter Assembly (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R2, R4 thru R7, R52	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	6		
R8	Res, comp, 220k ±5%, 1/2W	109025	01121	EB2245	1		
R9, R49	Res, comp, 1.8k ±5%, 1W	180331	01121	GB1825	2		
R12	Res, comp, 100k ±10%, 1W	109397	01121	GB1041	1		
R14, R47, R61, R62, R66	Res, comp, 120k ±5%, 1/4W	193458	01121	CB1245	5		
R16	Res, mf, 30.1k ±1%, 1/8W	293431	91637	MFF1-83012F	1		
R17, R18, R32, R43, R53, R57	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	6		
R19, R25	Res, ww, 40k ±0.1%	271403	89536	271403	2	1	
R20, R23	Res, selected				2		
R21, R26	Res, mf, 10 ±1%, 1/8W	268789	91637	MFF1-8A100F	2		
R24	Res, var, cermet 100 ±20%, 1/2W	267823	11236	190PC101B	1	1	
R27	Res, mf, 20k ±1%, 1/8W	291872	91637	MFF1-82002F	1		
R28, R29	Res, comp, 39k ±5%, 1/4W	188466	01121	CB3935	2		
R30	Res, mf, 11.3k ±1%, 1/8W	335414	91637	MFF1-81132F	1		
R31	Res, mf, 80.6k ±1%, 1/8W	312710	91637	MFF1-88062F	1		
R33	Res, comp, 180k ±5%, 1/4W	193441	01121	CB1845	1		
R34	Res, mf, 3.16k ±0.1%, 1/8W	340588	91637	MFF1-83161B	1		
R35	Res, mf, 21.5k ±0.1%, 1/8W	344440	91637	MFF1-82152B	1		
R36	Res, mf, 100k ±1%, 1/8W	248807	91637	MFF1-81003F	1		
R37	Res, var, cermet, 50k ±10%, 1/2W	330688	11236	190PC503B	1	1	
R39	Res, comp, 1.6k ±5%, 1/4W	266197	01121	CB1625	1		
R40	Res, var, cermet, 10k ±20%, 1/2W	267880	11236	190PC103B	1	1	
R41	Res, ww, 4.091M ±0.1%, 2W	412205	89536	412205	1	1	
R44	Res, var, cermet, 500 ±20%, 1/2W	267849	11236	190PC501B	1	1	

CHECK ERRATA

CHANGE #11

Table 602-9. MIS-4110 Ohms Converter Assembly (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R45	Res, ww, 272.84k ±0.08%, 1/2W	412197	89536	412197	1	1	
R46	Res, comp, 3.3k ±5%, 1/4W	148056	01121	CB3325	1		
R48, R71	Res, comp, 470 ±5%, 1/4W	147983	01121	CB4715	2		
R50, R51	Res, comp, 2.7k ±5%, 1/4W	170720	01121	CB2725	2		
R54	Res, var, cermet, 200k ±20%, 1/2W	381509	11236	190PC204B	1	1	
R55	Res, mf, 332k ±1%, 1/8W	289504	91637	MFF1-83323F	1		
R56	Res, ww 2.01k ±0.1%, 1/2W	412189	89536	412189	1	1	
R58, R67	Res, comp, 1k ±5%, 1/4W	148023	01121	CB1025	2		
R60	Res, mf, 1M ±1%, 1/8W	268797	91637	MFF1-81004F	1		
R63	Res, mf, 28k ±1%, 1/8W	291835	91637	MFF1-82802F	1		
R64	Res, mf, 21k ±0.5%, 1/8W	229484	91637	MFF1-82102D	1		
R65	Res, mf, 17.8k ±1%, 1/8W	349183	91637	MFF1-81782F	1		
R68	Res, comp, 560k ±5%, 1/4W	220533	01121	CB5645	1		
R69	Res, car, 300 ±5%, 1/4W	441519	80031	CR251-4-5P200 KT	1		
R70	Res, car, 200k ±5%, 1/4W	441485	80031	CR251-4-5P200KT	1		
U1	IC, Dgtl, C-MOS, NAND gates	375147	02735	CD4011AE	1	1	
U2, U3	IC, Dgtl, C-MOS, quad, clocked D latch	355149	02735	CD4042AE	2	1	
U4	IC, lin, opnl ampl	363515	34333	SG301A	1	1	
U5	IC, lin, opnl ampl	418566	12040	LM358N	1	1	
U6, U7	IC Res Network	380618	89536	380618	2	1	
	Case half, module	402990	89536	402990	2		
	Cover Module Case	402974	89536	402974	1		
	Decal, Ohms, Converter	413435	89536	413435	1		
	Guard, front	383356	89536	383356	1		
	Guard, rear	383364	89536	383364	1		
	Socket, component lead	343285	00779	2-331272-6	8		

NOTES:

1. FOR SCHEMATIC DIAGRAM SEE MIS - 1110.
2. FOR PCB DETAIL DWG. SEE MIS-3110.
3. FOR ASSEMBLY DWG. SEE MIS-4110.

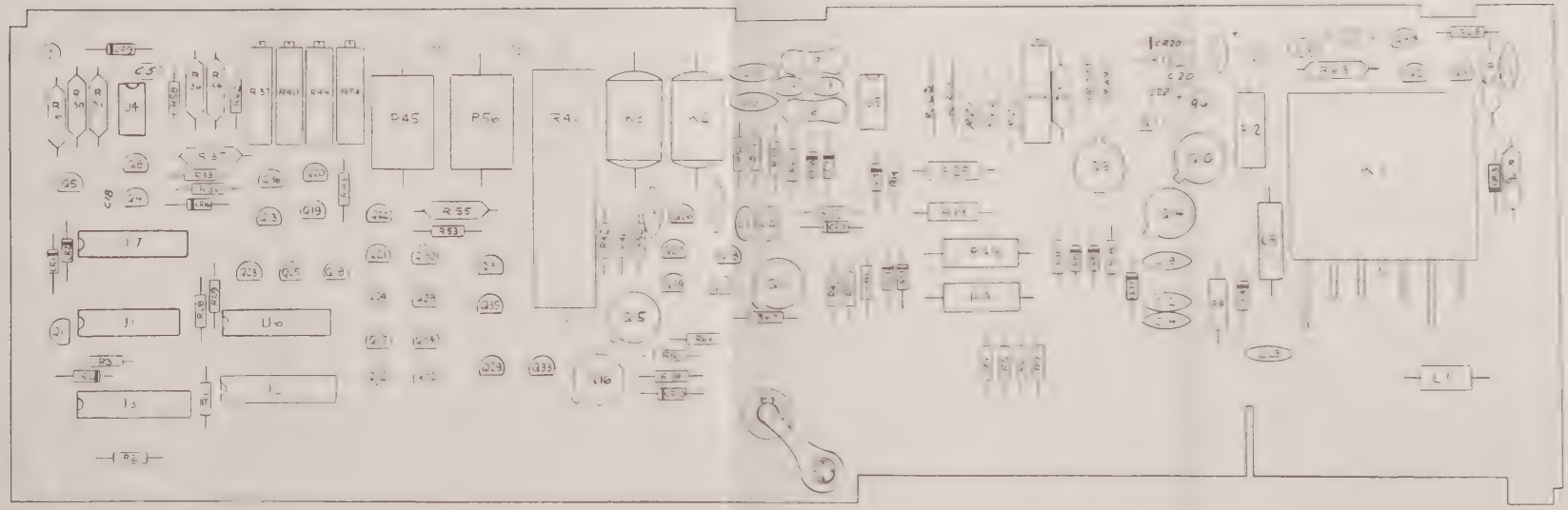
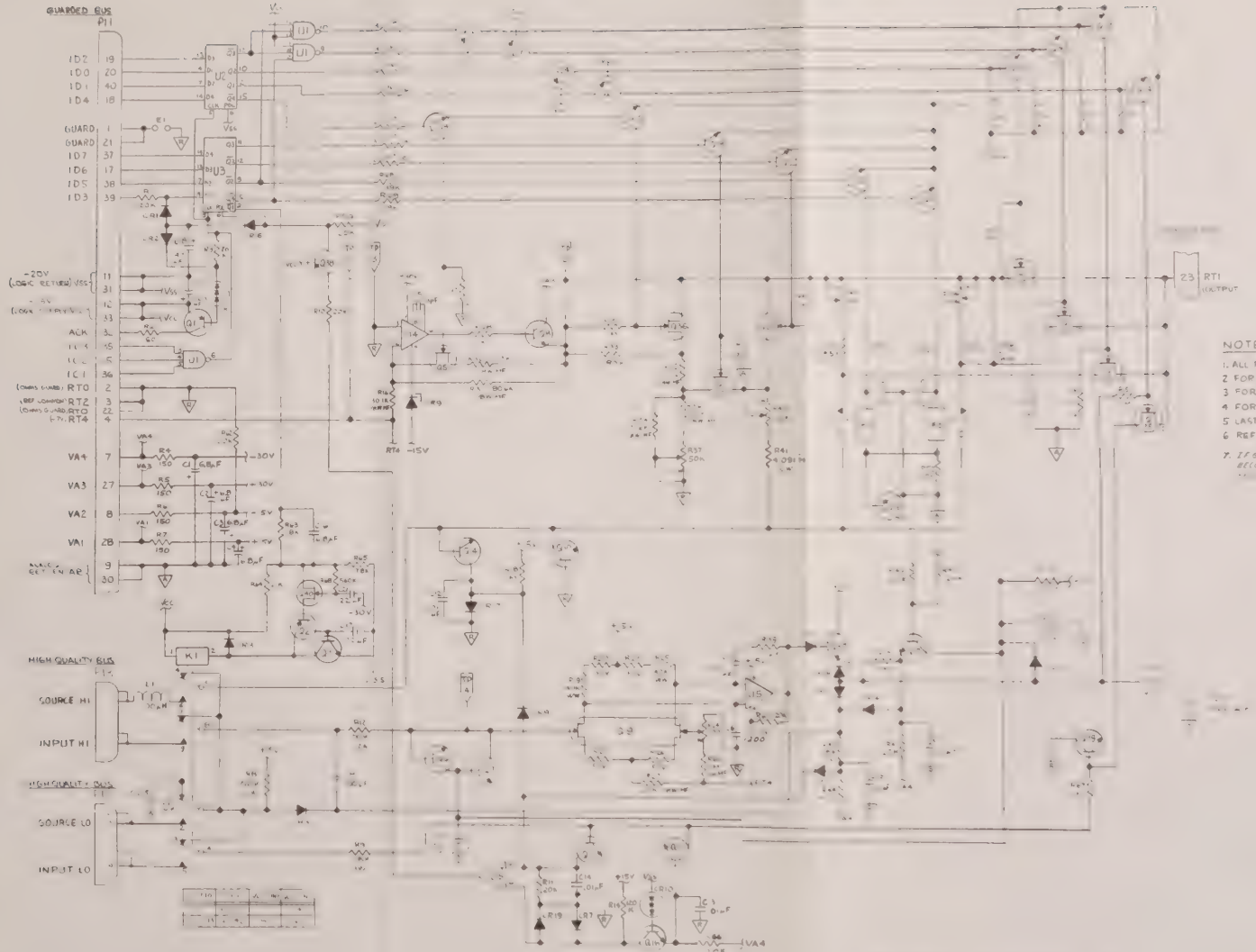


Figure 602-4. Ohms Converter, Assembly (M.I.S.-1710)

CHANGE # 11



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTORS ¼W, CC AND ALL RESISTANCE IN OHMS
2. FOR REF. DESIGNATION DWG SEE MIS-1710
3. FOR PCB DETAIL DWG SEE MIS-3110.
4. FOR ASSY. DWG SEE MIS-4110
5. LAST REF DES NOS USED: U17, Q40, CR70, K3, E, R70, C22.
6. REF DES NOS NOT USED: CR5, CR6, R13, R15, R22, R38.
7. IF R19 U; R19, R20, R21, R23, R25 OR R26 ARE TO BE CHANGED IT BECOMES NECESSARY TO TC THE MODULE PER MIS-4110-151 TEST

Figure 602-5. Ohms Converter (M.I.S.-1110)

Change/Errata Information

Issue No: 1 9/78

This change/errata contains information necessary to ensure the accuracy of the following manual. Enter the corrections in the manual if either one of the following conditions exist:

1. The instrument's PCB revision letter is lower than that which is indicated at the beginning of the change/errata.

2. No revision letter is indicated at the beginning of the change/errata.

MANUAL

Title: OPTION –03, CURRENT SHUNTS (8500A Digital Multimeter)

Print Date: JULY 1977

Rev and Date:

C/E PAGE EFFECTIVITY

Page No.	Print Date
1	9/78

Option –03

ERRATA #1

On page 603-1, under paragraph 603-8, place following note:

NOTE

Position sensitivity of switches requires that the instrument be operated within 30° of its horizontal position.

ERRATA #2

On page 603-5, paragraph 603-21, make the following changes:

Step 16, change R4 to R71.

Step 18, change R7 to R68.

Table 603-1. Current Shunts Specifications (Continued)

OPERATING CHARACTERISTICS

DIRECT CURRENT

Range	Full Scale	At Source 1 Res. (R_S)	Temperature 2 Coefficient	
			Voltage Burden	± (ppm/rdg + No. of Digits)/°C [3]
100 uA	312 uA	80 kΩ	≤100 mV	25 + 0.6
1 mA	2.5 mA	10 kΩ	≤100 mV	25 + 0.6
10 mA	20 mA	1.25 kΩ	≤200 mV	25 + 0.6
100 mA	160 mA	–	≤200 mV	35 + 0.6
1A	1.28A	–	≤500 mV	35 + 0.6

1 For Source Resistance less than specified, replace Temperature Coefficient with the following:

Temperature Coefficient:	*Range*	*+ No. of Digits/°C*
	100 uA	*0.5 (1 + 8k/R_S)*
	1 mA	*0.5 (1 + 1k/R_S)*
	10 mA	*0.5 (1 + 125/R_S)*

2 0°C to 18°C and 28°C to 50°C.

3 For high resolution multiply No. of digits by 10

OVERLOAD

1.5A maximum, ± 140V dc to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage.

PROTECTION

1-1/2A fuse

SETTLING & DIGITIZING TIME

Same as dc volts

ALTERNATING CURRENT

TEMPERATURE COEFFICIENT (0°C to 18°C and 28°C to 50°C)

RANGE	TEMPERATURE COEFFICIENT	
	RMS AC	AVG. AC
100 uA*	(50 ppm + 3.5 digits)/°C	(40 ppm + 1.5 digits)/°C
1 mA*	(50 ppm + 3.5 digits)/°C	(40 ppm + 1.5 digits)/°C
10 mA*	(50 ppm + 3 digits)/°C	(40 ppm + 1 digit)/°C
100 mA	(50 ppm + 9 digits)/°C	(40 ppm + 7 digits)/°C
1A	(50 ppm + 9 digits)/°C	(40 ppm + 7 digits)/°C

VOLTAGE BURDEN

Same as dc current

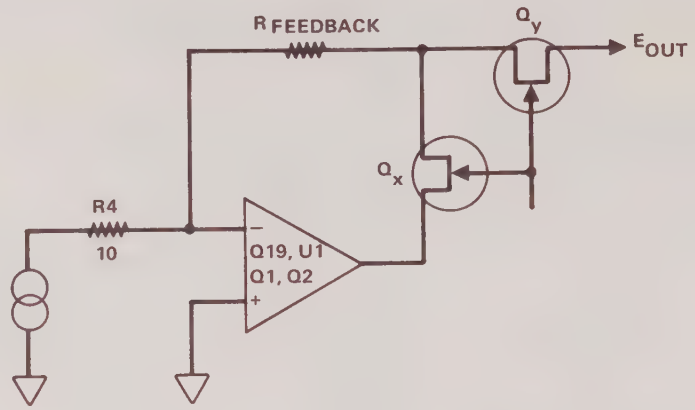
OVERLOAD

1.5A maximum current (1-1/2A fuse protected)
± 140V dc to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage.

CREST FACTOR (RMS only)

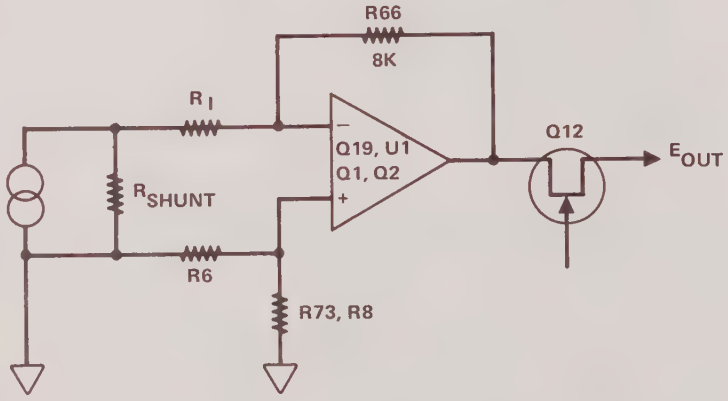
≤4.5 full scale, increasing down scale by:

$$4.5\sqrt{\frac{I_{Range}}{I_{Input}}}$$



MODE A – 100 μA, 1 mA, 10 mA

RANGE	$R_{FEEDBACK}$	Q_X	Q_Y	RELAYS	FULL SCALE E_{OUT}
100 μA	R30, R31	Q30	Q31	K3, K4	.8 V
1 mA	R33, R34	Q7	Q10	K3, K4	1.0 V
10 mA	R36, R37	Q9	Q8	K3, K4	1.25 V



MODE B 100 mA, 1A

RANGE	R_{SHUNT}	R_I	RELAYS	FET SWITCHES	FULL SCALE E_{OUT}
100 mA	R2, R1	R7, R70, R71	K1, K3	Q20, Q32, Q29, Q12	1.6V
1 A	R1	R7, R68, R69	K2, K3	Q20, Q29, Q28, Q12	2.0V

Q11 and either Q3 or Q4 will be conducting in all ranges

Figure 603-1. Current Shunt Configurations And Range Information

Option —03
Current Shunts

603-1. INTRODUCTION

603-2. Installation of the Current Shunts module allows current measurement in five ranges: 100 μA, 1mA, 10 mA, 100 mA, and 1 A. Either dc or ac current measurements may be made, but ac measurements require installation of one of the optional ac converters.

603-3. SPECIFICATIONS

603-4. Table 603-1 lists the specifications for the Current Shunts module. Accuracy specifications for the lower current ranges (100 μA, 1 mA, and 10 mA) depend on the source resistance of the current to be measured, due to the configuration of the measurement circuit. Source resistances only affect the number of floor digits, which can be determined from the formula given. For source resistances greater than specified, the number of uncertain digits will decrease. For ac currents, source resistance has a similar effect but the formula is much too complex for ordinary use.

603-5. INSTALLATION

603-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the Current Shunts module. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

603-7. OPERATING NOTES

603-8. Operation of the front panel switches is the same as described in Section 2 of this manual. Inputs to the Current Shunts module are between Source HI and Source LO. Sense HI and Sense LO may be left connected with the shorting links provided.

603-9. THEORY OF OPERATION

603-10. The function of the Current Shunt module is to generate a voltage proportional to the current to be measured. Outputs from the Current Shunt module are applied either to the DC Signal Conditioner for dc currents or to an optional ac converter for ac currents.

603-11. Two modes of operation are used in the Current Shunt module, depending on the range selected. Figure 603-1 illustrates the two configurations and contains tables relating resistors, switches, and relays to each range. Mode A is used for the 100 μA, 1 mA, and 10 mA ranges. Input currents are applied to the summing node (virtual ground) of an operational amplifier through R4. R4 ensures stability when the current source is highly capacitive, while presenting a very low voltage burden. The formula given for determining floor digits (uncertainty) in the accuracy specifications is based on the feedback resistors used in the three lowest ranges. For source resistances less than approximately 10 x $R_{FEEDBACK}$, the gain of the circuit becomes greater than one for error sources such as offset voltages and current noise. Thus the basic uncertainty (digits) of a measurement increases as the source resistance decreases. The output voltage is equal to the input current multiplied by $R_{FEEDBACK}$.

603-12. Mode B configures the amplifier as a difference amplifier measuring the voltage across a shunt. The ratio of the feedback resistor, R66, to R_I sets the gain of the amplifier at approximately 20 [$R66/R_I$ = (R8 + R73)/R6].

603-13. The amplifier consists of a dual FET (Q19), U1, Q1, and Q2. Refer to the schematic. R18 biases Q19 from the –7V reference (from the A/D Converter). R57 and R58 are selected to compensate for offset error (one of them will always be 10Ω). R55 and R56 are selected for temperature coefficient compensation. Q1 and Q2 are a complementary pair (for either polarity output) to increase the current output capability of the amplifier.

Table 603-1. Current Shunts Specifications

ACCURACY

(Refer to the specifications table in Section 1 for required environmental conditions)

DIRECT CURRENT

RANGE	FULL SCALE	AT SOURCE[1] RES. (R_s)	ACCURACY ±(% OF INPUT + NO. OF DIGITS[2])		
			24 HOURS	90 DAYS	1 YEAR
100 uA	312 uA	80 kΩ	0.02 + 10	0.03 + 10	0.05 + 10
1 mA	2.5 mA	10 kΩ	0.02 + 10	0.03 + 10	0.05 + 10
10 mA	20 mA	1.25 kΩ	0.02 + 10	0.03 + 10	0.05 + 10
100 mA	160 mA	—	0.03 + 20	0.05 + 20	0.1 + 20
1 A	1.28A	—	0.03 + 20	0.05 + 20	0.1 + 20

[1] *For Source Resistance less than specified, replace floor digit specification with following:*

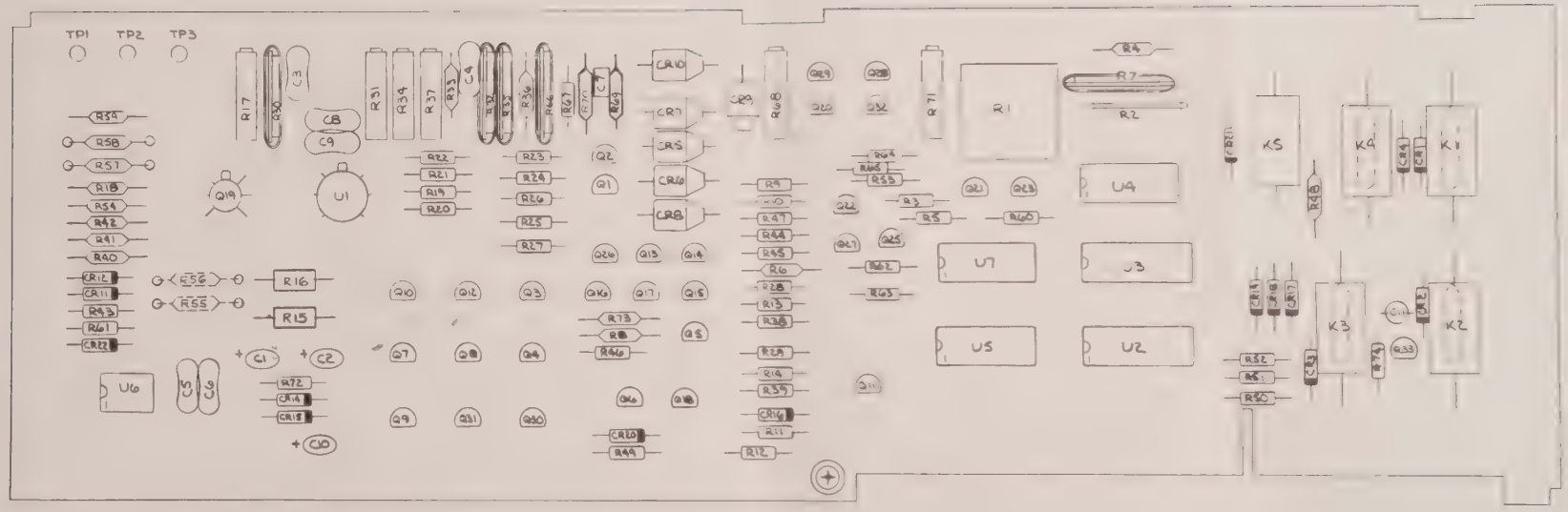
Accuracy: Range	*+ No. of Digits*
100 uA	*9 (1 + 8k/R_s)*
1 mA	*9 (1 + 1k/R_s)*
10 mA	*9 (1 + 125/R_s)*

[2] *For high resoltuion multiply the number of digits by 10.*

ALTERNATING CURRENT

Range	Full Scale	Frequency	Accuracy ±(% of Input + No. of Digits) from 0.1% of full scale to full scale:					
			24 Hours		90 Days		1 Year	
			Average Current	True RMS Current	Average Current	True RMS Current	Average Current	True RMS Current
100 uA*	312.5 uA	10 Hz–20 Hz	—	0.7 + 110	—	1.0 + 110	—	2.0 + 110
		20 Hz–50 Hz	0.55 + 9	0.55 + 35	0.8 + 9	0.8 + 35	1.6 + 10	1.6 + 35
		50 Hz–10 kHz	0.3 + 9	0.28 + 35	0.4 + 9	0.4 + 35	0.8 + 10	0.8 + 35
		10 kHz–20 kHz	0.5 + 9	0.7 + 110	0.7 + 9	1.0 + 110	1.5 + 10	2.0 + 110
		20 kHz–50 kHz	1.0 + 9	1.0 + 260	1.5 + 9	1.5 + 260	3.0 + 10	3.0 + 260
		50 kHz–100 kHz	2.0 + 9	2.8 + 760	3.0 + 9	4.0 + 760	6.0 + 10	8.0 + 760
1 mA* and 10 mA*	2.5 mA 20 mA	10 Hz–20 Hz	—	0.7 + 110	—	1.0 + 110	—	2.0 + 110
		20 Hz–50 Hz	0.35 + 9	0.35 + 35	0.5 + 9	0.5 + 35	1.0 + 9	1.0 + 35
		50 Hz–10 kHz	0.05 + 9	0.08 + 35	0.06 + 9	0.11 + 35	0.12 + 9	0.22 + 35
		10 kHz–20 kHz	0.08 + 9	0.14 + 110	0.11 + 9	0.2 + 110	0.22 + 9	0.4 + 110
		20 kHz–50 kHz	0.08 + 9	0.2 + 260	0.12 + 9	0.3 + 260	0.24 + 9	0.6 + 260
		50 kHz–100 kHz	0.35 + 9	0.7 + 760	0.51 + 9	1.0 + 760	1.0 + 9	2.0 + 760
100 mA	160 mA	10 Hz–20 Hz	—	0.7 + 150	—	1.0 + 150	—	2.0 + 150
		20 Hz–50 Hz	0.34 + 55	0.35 + 80	0.5 + 55	0.5 + 80	1.0 + 55	1.0 + 80
		50 Hz–10 kHz	—	0.18 + 80	—	0.26 + 80	—	0.52 + 80
		50 Hz–100 kHz	0.16 + 55	—	0.24 + 55	—	0.5 + 55	—
1A	1.28A	10 Hz–20 Hz	—	0.7 + 150	—	1.0 + 160	—	2.0 + 160
		20 Hz–50 Hz	0.34 + 65	0.35 + 90	0.5 + 65	0.5 + 90	1.0 + 65	0.5 + 90
		50 Hz–10 kHz	0.16 + 65	0.18 + 90	0.24 + 65	0.26 + 90	0.5 + 65	0.52 + 90

**Minimum Source Resistance, same as for Direct Current.*



NOTES:

1. FOR SCHEMATIC DIAGRAM SEE MIS-1104.
2. FOR PCB DRAWING SEE MIS-3104
3. FOR ASSY DRAWING SEE MIS-4104.
4. R55 & R56 WILL BE DETERMINED DURING TEST RESISTORS MAY BE INSTALLED.
5. R73, R33, R74 & R44 ARE SLEEVED

Figure 603-3. Current Shunt Assembly (M.I.S.1704)

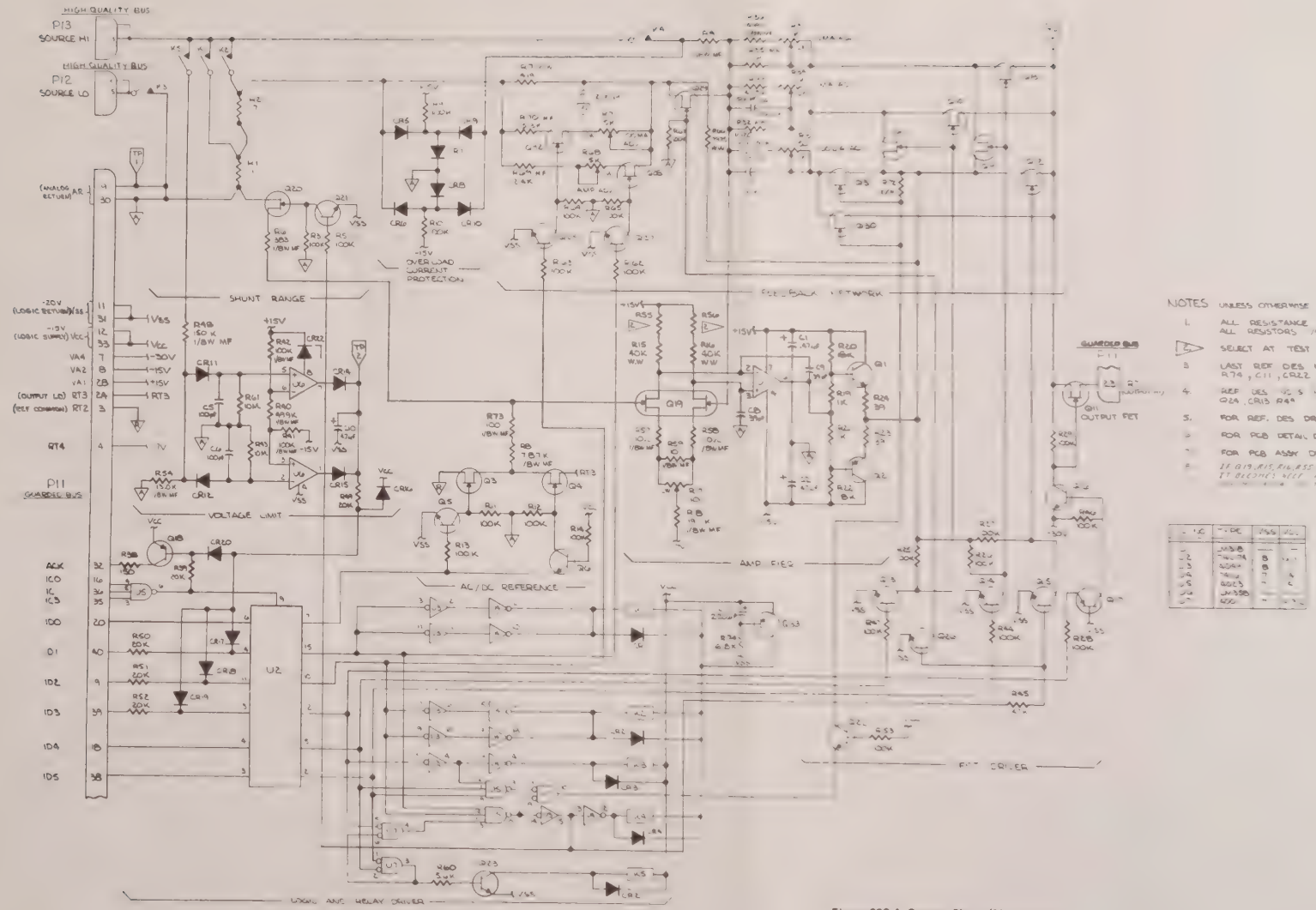


Figure 603-4. Current Shunt (M.I.S.1104)

Option —04
Calibration Memory

604-1. INTRODUCTION

604-2. Installation of the Calibration Memory module permits extended calibration intervals while maintaining the accuracy of the instrument. A calibration factor is entered into memory with a single keystroke. Calibration factors are determined by comparison to a standard at the cardinal point for each function and range. An input of +1.000000V dc would be the cardinal point for the 1V dc range. A non-volatile memory allows storage of calibration factors for at least one year or until the instrument is completely recalibrated.

604-3. SPECIFICATIONS

604-4. DC Zero, Ohms Zero, and calibration factors for the cardinal points of every range and function will be maintained for at least one year with no power applied to the instrument.

604-5. INSTALLATION

604-6. Refer to Section 4 of this manual under Module Installation and Removal for installation procedures. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

604-7. OPERATING NOTES

604-8. When the Calibration Memory module is installed, care must be exercised when using the instrument in the high resolution mode. Inadvertently depressing the STORE switch while in the high resolution mode will erase the cal factor for that function and range from memory and enter an erroneous factor. Use the following procedure to enter calibration factors.

1. Ensure that the DC Zero and Ohms Zero procedures have been performed.
2. Verify that the EXT REF and OFFSET indicators are extinguished.
3. Select the Cal mode (CAL indicator illuminated).
4. Select the desired function and range.
5. Apply an input from a calibration source equal to the value of the cardinal point at the function and range selected (e.g., with 10V dc selected apply +10.000000V dc).
6. Depress the STORE switch. The reading displayed should be equal to the value of the input ± the listed specification as long as the switch is held in.
7. Repeat steps 4, 5 and 6 for each applicable function and range.
8. Depress the RECALL switch to display the last uncorrected reading taken while in the Cal Memory mode. The reading is displayed until the switch is released.
9. To remove Calibration factors from the Cal Memory, use the foregoing procedure, except in step 5 use a short (an open for current factors) at the input terminals instead of the calibration source.

NOTE

Correction factors entered for the V ac rms feature automatically correct any reading in dc coupled ac.

604-9. THEORY OF OPERATION

604-10. The Calibration Memory module provides non-volatile read/write memory used to store calibration constants and dc and ohms zero factors. When the dc or ohms functions are selected, the appropriate zero factor (if one was entered) is brought out by the instrument controller for storage within the controller module. Likewise, when a new function or range is selected, calibration constants are read from and stored for immediate use within the controller module.

604-11. This module was designed for use in more than one instrument, so there are land patterns and some devices which are not used in this particular instrument on the pcb. The following discussion is keyed to the schematic, Figure 604-1.

604-12. RAM Location Addresses

604-13. RAM location addresses are sent to the Calibration Memory module on the instrument data bus, ID0-7. Address IC1, 2, 6 clocks the data into U23 through U15-10, and U14-12. Outputs from U23 determine the location in the RAMs that data will be written or read.

604-14. Write Operation

604-15. Addresses used in both read and write operations are true 3 of 7 codes in which three IC lines must be high and four low to obtain a response. Writing data into memory first requires an address (IC3, 4, 5 high) and a data key (ID 0, 3, 5, 6 high, ID 1, 2, 4, 7 low) to set the circuitry into the write mode. The address is decoded by U15-9, U14-1 ANDed by U13-3 (VA1). The data key is decoded by U24-13, U24-1 ANDed by U13-4 (KEY). VA1 and KEY are ANDed by U2-11 to produce the ACK response (U17, Q1) and to set U12-2 low (WRITE) through U25-10. The module is now set into the write mode.

604-16. The next address (IC0, 2, 6 high) is decoded by U15-6, U14-13 ANDed by U13-10 (VA2). VA2 triggers a one-shot multivibrator, U1-4, so U2-5, 6 are both low and VA2·WRITE is true (low) which sets the RAMs into the write mode. U12-1 is high so U2-3 is high which disables the outputs of the RAMs (OD). Data to be written into the RAMs accompanies this address and is stored in the memory location previously clocked into U23. At termination of the address, VA2 goes high clocking U12-1 low and U12-2 high, which sets the module into the read mode.

604-17. Read Operations

604-18. The module stays in the read mode unless set into the write mode. Read operations require the address resulting in VA2 as previously explained. This time U12-1 is low (READ). U2-3 goes low enabling the RAM outputs. U2-4 is high setting the RAMs (R/W) into the read mode. The desired memory location must have been clocked into U23 prior to the READ address.

604-19. TROUBLESHOOTING

604-20. Problems in the Calibration Memory can cause apparent problems in all functions of the instrument. The most common problem is wrong values entered. The recall feature may be used to determine the value of the stored correction factor. Since correction factors are multipliers, the stored value will be close to one and consequently difficult to display meaningfully. Instead, the last uncorrected reading is displayed when in the CAL mode, and the RECALL switch is depressed. Dividing the cardinal value for the selected range into the last uncorrected reading results in the stored constant. By using the recall feature, it is fairly easy to determine if a reasonable cal constant is stored.

604-21. The three following checks may be made to determine if the Calibration Memory is functioning properly.

1. Store zeros for all functions and ranges, then recall the zero values.

2. Store cardinal points for all functions and ranges, then recall for the last uncorrected reading.

3. Remove power for two or more hours (to ensure that the RAMs have discharged C7 to the battery level), then reapply power and recall as in 1 and 2. This checks the shift of RAM power supply from Vcc to battery and back to Vcc. The purpose of C7 is to remove glitches in the RAM supply which can scramble entries stored in RAM.

604-22. Table 604-1 lists the test points found on the Calibration Memory module. Table 604-2 gives a symptom analysis approach to troubleshooting.

604-23. PARTS LIST

604-24. Table 604-3 gives a parts breakdown for the Calibration Memory module. Refer to Section 5 of this manual for ordering and use code information.

Table 604-1. Test Points

TP1 — Vss; logic return, use as LO return for test instrument
TP2 — VA2 · READ; low for the controller to read from cal memory goes low 3 or 4 times every 200 msec
TP3 — VA2 · WRITE; low for the controller to write into cal memory goes low 4 times for every STORE switch push
TP4 — RAM Supply Voltage; when power is on =Vcc — .6V when power is off = battery voltage
TP5 — Negative Battery Terminal
TP6 — Vcc; Logic Supply
TP7 — ACK; acknowledge signal returned when module addressed

Table 604-2. Symptom Analysis

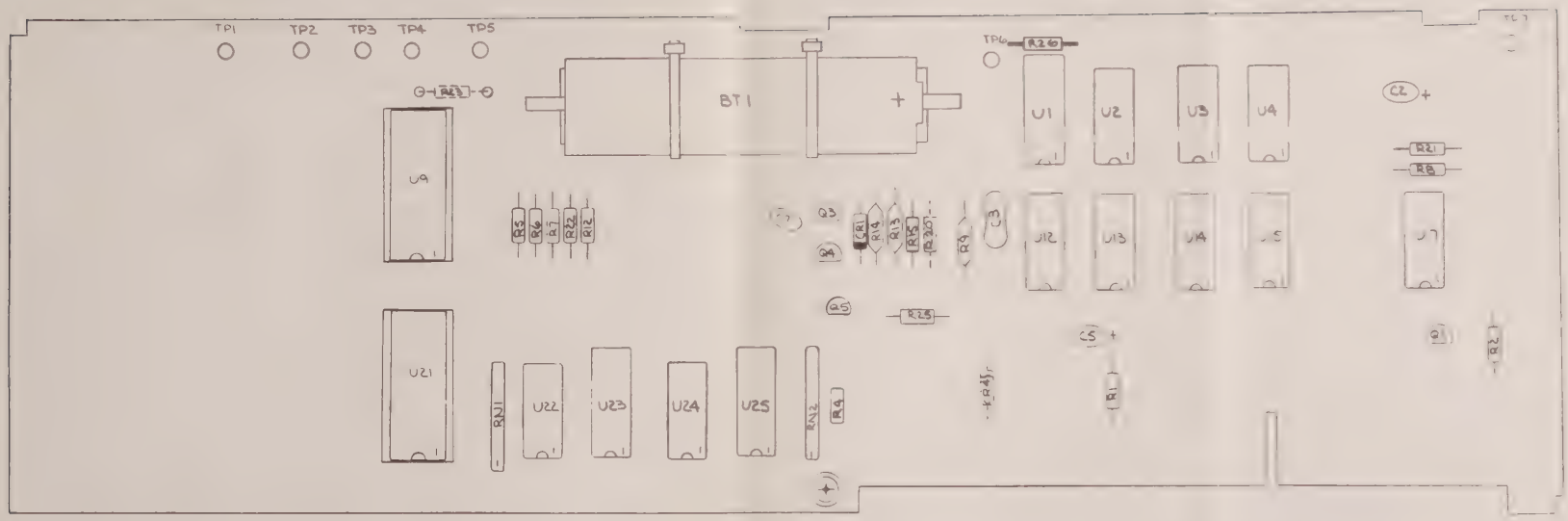
SYMPTOM	POSSIBLE FAILURE
Won't Store	VA2 · WRITE missing; check TP3
Won't Read	VA2 · READ missing; check TP2
Error at Turn-On	Battery voltage bad at TP4, RAM defective, not reading
Wrong Readings	U23 (RAM address latch), RAM defective, wrong data stored

Table 604-3. Calibration Memory Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Ⓧ	**CALIBRATION MEMORY ASSEMBLY** **Figure: 604-1**						
BT1	Battery Lithium (use when R20 & CR4 are not installed)	408286	89536	408286	1		G
BT1	Battery Lithium (see above)	448498	89536	448498			H>
BT1	Battery Ni-cad (use when R20, CR4 and U9, U21 P/N 408757 are installed)	412890	06001	PPS2092	1		
C2	Cap, Ta, 0.47 uF ±20%, 35V	161349	56289	196D474X0035 HA1	1		
C3	Cap, mica, 180 pF ±5%, 500V	284786	72136	DM15F181J	1		
C4	Cap, Ta, 0.33 uF ±20%, 35V	408690	56289	196D334X0035 HA1	1		
C5	Cap, Ta, 1 uF ±20%, 35V	161919	56289	196D105X0035 JA1	1		
C6	Cap, mica, 390 pF ±5%, 500V	148437	72136	DM15F391J	1		
C7	Cap, Ta, 10 μF ±20%, 15V	193623	56289	1960106X 0015KA1	1		
CR1, CR2	Diode Hi-speed switching	203323	07910	1N4448	3	1	
CR4	Diode, Hi-speed switching (use with U9, U21 when P/N408757 installed)	203323	07910	1N4448	REF		
Q1	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
Q3	Xstr, Si, NPN	168716	89536	168716	1	1	
Q4	Xstr, FET, N-channel	370072	89536	370072	1	1	
Q5	Xstr, Si, PNP	195974	04713	2N3906	1	1	
R1	Res, car, dep, 150 ±5%, 1/4W	343442	80031	CR251-45P151T	1		
R2, R11	Res, car, dep, 47k ±5%, 1/4W	348896	80031	CR251-45P473T	1		
R4 thru R8, R12, R15, R16, R21, R22, R24, R25	Res, car, dep, 100k ±5%, 1/4W	348920	80031	CR251-45P101T	12		
R9	Res, mf, 10k ±1%, 1/8W	168260	91637	MFF1-81002F	1		
R10	Res, mf, 130k ±1%, 1/8W	221648	91637	MFF1-81303F	1		
R13	Res, mf, 34k ±1%, 1/8W	261602	91637	MFF1-83402F	1		

Table 604-3. Calibration Memory Assembly (Concluded)

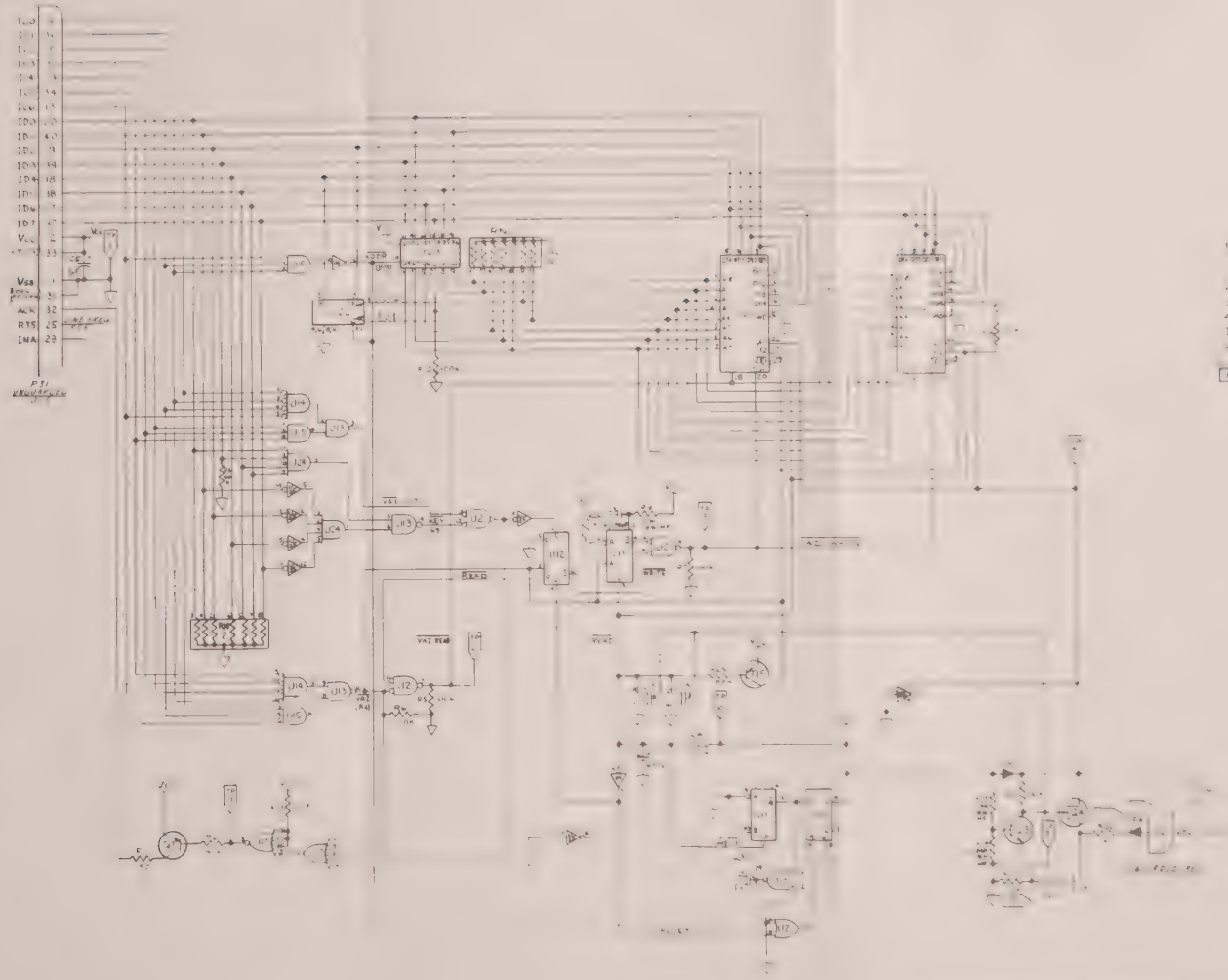
REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R14	Res, mf, 6.04k ±1%, 1/8W	285189	91637	MFF1-86041F	1		
R20	Res, car, dep, 1k ±5%, 1/4W (use with U9, U21 when P/N 308757 is installed)	343426	80031	CR251-45P102T	1		
RN1, RN2	Res Network	412908	89536	412908	2	1	
U1	⊗ IC, Dgtl, TTL, lo-pwr Schottky	404186	01295	SN74LS123N	1	1	
U2	⊗ IC, Dgtl, C-MOS, quad, 2-input OR gates	408393	18725	CD4071BE	1	1	
U3, U4	⊗ IC, Dgtl, C-MOS, dual complimentary pair plus inverter	408013	02735	CD4007AE	2	1	
U9, U21	⊗ IC, Dgtl, C-MOS, 1024 bit, static RAM (use with 408286)	429860	34649	P5101L	2	1	
U9, U21	⊗ IC, Dgtl, C-MOS, 1024 bit, static RAM (use with 412890)	408757	34649	P5101L-3	2	1	
U12, U22	⊗ IC, C-MOS, dual "D" type, flip-flop	340117	02735	CD4013AE	2	1	
U13	⊗ IC, Dgtl, C-MOS, quad, 2-input NAND gates	355198	02735	CD4011AE	1	1	
U14	⊗ IC, COS/MOS, dual 4-input NOR gates	363820	02735	CD4002AE	1	1	
U15	⊗ IC, Dgtl, C-MOS, triple, 3-input AND gate	408807	02735	CD4073B	1	1	
U17, U24	⊗ IC, Dgtl, C-MOS, dual 4-input AND gate	408799	02735	CD4082B	2	1	
U23	⊗ IC, Dgtl, C-MOS, hex "D" flip-flop	404509	12040	MM74C174N	1	1	
U25	⊗ IC, Dgtl, C-MOS, hex, inverter/buffer	381848	02735	CD4049AE	1	1	
U26	⊗ IC, Dgtl, COS/MOS quad exclusive OR gate	355222	02735	CD4030AE	1	1	
	Case half, module	402990	89536	402990	2		
	Cover Module Case	402974	89536	402974	1		
	Decal, cal. memory	413484	89536	413484	1		
	Guard, front	383356	89536	383356	1		
	Guard, rear	383364	89536	383364	1		
	Shield, cover	411975	89536	411975	1		
	Socket, component lead	343285	00779	2-331272-6	2		
	Socket, IC, 22 pin	453126	91506	322-AG39D	2		



NOTES

1. FOR SCHEMATIC DIAGRAM SEE 8500A-1160
2. FOR P.C.B. SEE M15-3160
3. FOR ASSY DRAWING SEE 8500A-4160
4. R20 & CR4 WILL ONLY BE INSTALLED WHEN A NI-CAD BATTERY IS INSTALLED
5. R25 WILL BE REPLACED BY A JUMPER WHEN A NI-CAD BATTERY IS INSTALLED

Figure 604-1. Calibration Memory Assembly (8500A-1760)



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTOR ARE 1/4W, ±5%, ALL RESISTANCE IN OHMS
2. FOR REF DESIGNATION SEE 8500A-1760
3. FOR PCB DETAIL SEE MIS 3160
4. FOR ASSY DWG SEE 8500A-4160
5. LAST REF DES NO'S USED: J25, D5, CR4, C7, RN2, R23, BT1
6. REF DES NO'S NOT USED: U5-U8, U10, U11, U16, U18-U20, R3, R17-R22, C13, C14, C15, R1, R16, R24, CR2, C4, AND C6
7. CR4 & R20 ARE ONLY USED WHEN NICAD, CADMIUM BATTERY (BT1) IS INSTALLED.

(A) R23 WILL BE INSTALLED WHEN USING LITHIUM BATTERY.
A JUMPER WILL BE INSTALLED WHEN USING NI-CAD BATTERY.
CAUTION - THIS ITEM SHOULD BE INSTALLED DURING TEST, TO AVOID CURRENT DRAIN FROM BATTERY, WHICH COULD OCCUR DUE TO INSTALLATION OF FAULTY COMPONENTS.

Figure 604-2. Calibration Memory (8500-1160)

Option -05
IEEE-488 Interface

605-1. INTRODUCTION

605-2. This manual will specifically describe the IEEE Interface (Option -05); refer to the IEEE standard for general IEEE-488 bus interface information. Descriptions unique to the IEEE Interface will be presented separately from Programming Instructions in this manual. The Systems Multimeter Programming Card provided with the DMM lists condensed programming instructions. Refer also to Fluke Application Bulletins 25 and 36, and the IEEE Standard 488-1975 Digital Interface for Programmable Instrumentation.

605-3. SPECIFICATIONS

605-4. Specifications for the IEEE 488-1975 Standard Interface, Option -05, conform to those established in the IEEE Standard Digital Interface for Programmable Instrumentation as published by the Institute of Electrical and Electronics Engineers; 345 E. 47th Street, New York, N.Y. 10017. For an explanation of the IEEE 488-1975 Standard, refer to the Standard Document.

605-5. INSTALLATION

605-6. The IEEE-488 Interface is easily installed as a module in the 8500 Series DMM. Use the following installation procedure:

1. On the DMM, press power OFF and remove the line power cord.

2. Remove the DMM's top cover.

3. The Interface module fits in the rear slot, bus connector and addresss switches facing to the rear. Slide the module vertically between the module guides, and press firmly into place.

NOTE

Make sure the leaf spring, attached to one-half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

4. If installed, remove the Interconnect PCB from slot K. This slot can be identified as the only slot with connectors on the analog and digital bus lines. To remove the Interconnect PCB, grasp the board at both ends and pull up. An end-to-end rocking motion may be necessary to free the PCB from its connectors.

5. The Isolator module must be installed in slot K whenever a remote interface (Option -05, -06 or -07) is used in the DMM.

NOTE

Use Isolator -08 with the 8500A; Isolator -08A must be used with the 8502A.

6. Connect the Interface to the IEEE-488 Bus. Attach a standard 24-pin cable to the bus connector accessed through the DMM's rear panel. Standard cables, listed in Table 605-1, are available from John Fluke Mfg. Co., Inc.

7. Optionally, connect the cable shield to chassis ground. The shield, pin 12 in the connector, is accessed from the rear panel via a banana jack. Chassis ground is available at a binding post on the DMM's rear panel.

8. Set the Interface address switches (A1-A5) as required. Controls and connections accessed through the rear panel are illustrated in Figure 605-1. Refer to Table 605-2 for permissable address settings. Depressing a switch to the bottom sets the associated address bit true (true = 1). TALK address bits T1 through T5 are equal to LISTEN address bits L1 through L5.

NOTE

If the other devices in the system are listeners only, the DMM may be place in TALK ONLY mode by toggling the TALK/ ADDRESSABLE switch; access to this switch is through the rear panel.

9. Replace the DMM's top cover.

10. Energize the DMM.

11. Remote operation can be entered by transmitting any character that the DMM will recognize from the remote controlling terminal. When remote operation is entered, use of DMM front panel switches (other than RESET or POWER) will be ignored.

Table 605-1. IEEE-488 Standard Cables

ORDER NUMBER	DESCRIPTION
Y8001	IEEE-488 Cable, 1 meter
Y8002	IEEE-488 Cable, 2 meters
Y8003	IEEE-488 Cable, 4 meters

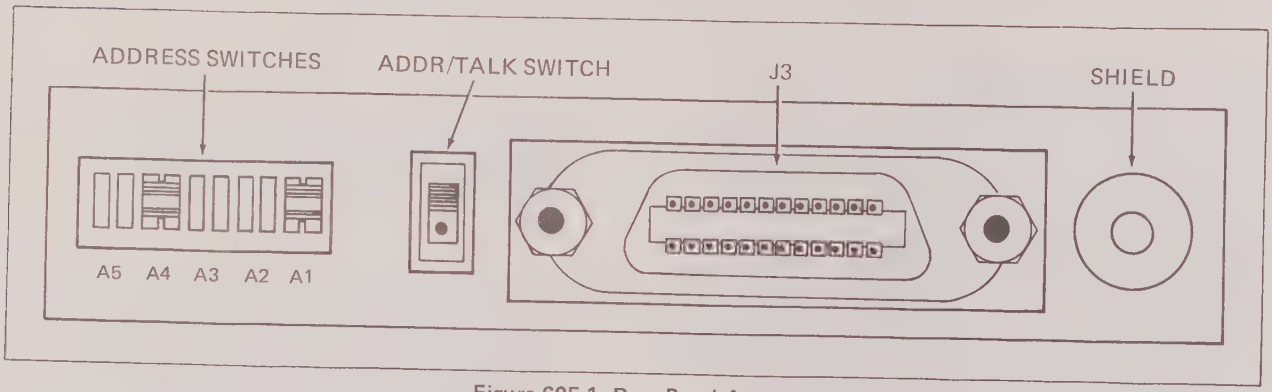


Figure 605-1. Rear Panel Access

Table 605-2. Allowable Listen and Talk Addresses

DECIMAL	5 4 3 2 1 BINARY	ASCII CHARACTER		DECIMAL	5 4 3 2 1 BINARY	ASCII CHARACTER	
		LISTEN	TALK			LISTEN	TALK
0	0 0 0 0 0	SP	@	16	1 0 0 0 0	0	P
1	0 0 0 0 1	!	A	17	1 0 0 0 1	1	Q
2	0 0 0 1 0	"	B	18	1 0 0 1 0	2	R
3	0 0 0 1 1	#	C	19	1 0 0 1 1	3	S
4	0 0 1 0 0	$	D	20	1 0 1 0 0	4	T
5	0 0 1 0 1	%	E	21	1 0 1 0 1	5	U
6	0 0 1 1 0	&	F	22	1 0 1 1 0	6	V
7	0 0 1 1 1	'	G	23	1 0 1 1 1	7	W
8	0 1 0 0 0	(	H	24	1 1 0 0 0	8	X
9	0 1 0 0 1	)	I	25	1 1 0 0 1	9	Y
10	0 1 0 1 0	*	J	26	1 1 0 1 0	:	Z
11	0 1 0 1 1	+	K	27	1 1 0 1 1	;	[
12	0 1 1 0 0	,	L	28	1 1 1 0 0	<	\
13	0 1 1 0 1	–	M	29	1 1 1 0 1	=	]
14	0 1 1 1 0	.	N	30	1 1 1 1 0	>	↑
15	0 1 1 1 1	/	O				

605-7. OPERATING FEATURES

605-8. Attached to the assembly and accessible through a port on the rear panel (Figure 605-1) are a standard specified connector, five address switches and a Talk Only Mode switch. The connector is standard for the IEEE bus and is specified by the standard document. The address of the instrument is set using the five address switches. The characters used to address the instrument in the talk and listen mode are given in Table 605-1. The five low order bits of the message determine the address, the next two higher bits differentiate between the Talk and Listen modes. Normal operation allows the instrument to both talk and listen to the bus. The Listen mode can be disabled with the Talk Only switch, if desired.

605-9. OPERATING NOTES

605-10. Interface Control

605-11. Information is input to the interface from the controller on the system bus, which contains eight data lines, three handshake lines and five bus management lines. Control of the handshake and management lines is from the controller and will vary with the controller used. Refer to the instructions with the system controller for the information on how to obtain the correct level on these lines. The lines and a brief explanation of their function are given in Table 605-3. Refer to the IEEE 488-1975 Standard Manual for a further explanation of their function.

605-12. Interface Messages

605-13. Multiple line messages are input to the interface from the controller using the data lines. The messages used within the instrument are listed with their codes in Table 605-4. Further information on the messages can be obtained from the IEEE 488-1975 Standard Manual.

605-14. Status Request Responses

605-15. If enabled by the applicable Interface Interrupt Enable Code, a service request (SRQ) can be generated within the interface by either an error or ready condition. When the instrument is addressed during a serial poll operation by the IEEE 488 Controller, and an interrupt is generated, the response byte will be a zero for ready or the numeric of the applicable Error Code. If the SRQ was not generated, the response is a null character (binary 000000000) to the controller.

605-16. THEORY OF OPERATION

605-17. The IEEE Interface provides for communication between the IEEE system bus and the DMM internal bus structure. The IEEE system bus is defined by the IEEE standard; the DMM internal bus structure is discussed in the instrument Instruction Manual. System bus signal lines will be referred to by their mnemonic designators (refer to Table 605-3 for definitions).

605-18. The IEEE Interface consists of two interconnected pcb's in one module. Each pcb will have its own reference designator system. To distinguish between the two, reference designators mounted on the Piggyback board will be followed by a (PB).

605-19. Data Lines

605-20. System bus data lines (DI01-08) are applied to the interface through receiver/drivers, U21 and U24. The receivers consist of noninverting buffers, while the drivers are gates with a common enable line from U32-8.

NOTE

True conditions on the system data bus are defined as a low; true conditions on the instrument bus are defined as a high.

Outputs from the data line receiver drivers are applied directly to address decoders, U19 and U12, through address switch S1 to address decoders U6 and U3, and through inverters to a data register consisting of U30 and part of U31.

605-21. The internal DMM data bus is applied to a response register consisting of U26 and U29. This register latches data up for application to the system bus lines (the system bus requires that data be held longer than is desirable to tie up the instrument controller). Instrument data is also applied to the control register on the Piggyback board (U11-PB, U16-PB, U14-PB).

605-22. Addresses

605-23. Instrument address lines (IC0-IC6) are applied to address decoders located on the Piggyback board. All of the following listed addresses cause an ACK to be returned to the instrument controller through U6 (PB)-1.

1. IC 1, 5 and 4 High: Decoded U12 (PB)-6 to enable the response register.
2. IC 6, 4 and 3 High: U12(PB)-10 to clock data into the control register; if ID0 is high, this address also causes a Return to Local signal from U8(PB)-3.
3. IC 5, 3 and 0 High: Decoded by U13(PB)-6 to cause a software reset through U8(PB)-10.
4. IC 6, 0 and 4 High: Decoded by U13(PB)-9 to enable the status register (U28 and part of U31).
5. IC, 6, 1 and 4 High: Decoded by U13(PB)-10 to enable the data register (U30 and part of U31).

605-24. Addresses to the IEEE Interface from the system are received on the data lines when ATN is true. Address switch S1 routes My Listen Address (MLA) and My Talk Address (MTA). Decoding for MLA is done by U6-13; the DAV signal clocks this address into U11-1. The MTA flip-flop U11-1 is cleared by the UNL (Unlisten) signal (decoded by U19-13). The Message Decoder (U9, U5 and U8) is enabled by the ATN and U12-10 (decoded by DI02, DI06, DI07).

Table 605-3. Mnemonics

PIN	MNEMONICS	FUNCTION	COMMENTS
1	DIO 1	Data	
2	DIO 2	Data	
3	DIO 3	Data	
4	DIO 4	Data	Data input/output lines. Message bytes are carried on the DIO lines in a bit-parallel byte-serial form, asynchronously, and generally in a bidirectional manner.
13	DIO 5	Data	
14	DIO 6	Data	
15	DIO 7	Data	
16	DIO 8	Data	
5	EOI	End Or Identify	Used to indicate the end of a nultiple byte message.
6	DAV	Data Available	Is asserted TRUE by the sender of data when NRFD goes TRUE, remains TRUE until NDAC is sent TRUE by the data receiver.
7	NRFD	Not Ready For Data	When all devices are ready to receive data this line goes high. Remains high until DAV is sent TRUE.
8	NDAC	Not Data Accepted	When all receiving devices are through with the data on the bus, this line goes high, indicating that the sender may remove the data and set DAV low. When DAV goes to the receiving devices then pull NDAC low again.
9	IFC	Interface Clear	Sent high by the controller. It places all device interfaces in a known quiescent state.
10	SRQ	Service Request	This line is used by any device to get the attention of the controller.
11	ATN	Attention	Used by the controller to notify all other devices what type of message (interface versus device dependent) is on the data bus. When ATN is TRUE, messages sent are interface messages and all devices capable of receiving messages must handshake the transfer. When false, device dependent messages are sent and only devices that have been addressed remain active.
12		Shield*	Surrounds all conductors.
17	REN	Remote Enable	Must be TRUE to place instruments into remote. Once in Remote, if REN goes false all instruments must go to local.
18	GND	Return for DAV	
19	GND	Return for NRFD	
20	GND	Return for NDAC	
21	GND	Return for IFC	
22	GND	Return for SRQ	
23	GND	Return for ATN	
24	GND	Logic common for DIO 1-DIO 8, EOI, and REN	

**The cable shield is routed to a banana jack on the rear of the Option –05 interface adjacent to the programming conductor. This banana jack may be tied to the DMM chassis ground post located on the rear panel. However, caution must be exercised to prevent ground loops in the system.*

Table 605-4. Interface Messages

MNEMONIC	MESSAGE	CODING			ALL DEVICES RESPOND (Universal)	ADDRESSED DEVICES ONLY RESPOND	DEVICE IN LOCAL RESPONDS AND GOES TO REMOTE	NOTE
		BINARY	OCTAL	HEX				
MLA	My Listen Address	X F T A5 A4 A3 A2 A1				X	X	1
MTA	My Talk Address	X T F A5 A4 A3 A2 A1				X	X	1
UNL	Unlisten	X F T T T T T T	077	3F	X			
UNT	Untalk	X T F T T T T T	137	5F	X		X	
OTA	Other Talk Address	X X X X X X X X					X	2
SPE	Serial Poll Enable	X F F T T F F F	030	18	X		X	
SPD	Serial Poll Disable	X F F T T F F T	031	19	X		X	
LLO	Local Lockout	X F F T F F F T	021	11	X		X	
GTL	Go To Local	X F F F F F F T	001	01		X		
DCL	Device Clear	X F F T F T F F	024	14	X			
SDO	Selected Clear	X F F F F T F F	004	04		X		

605-25. Resets

605-26. Power-on or software resets may occur. At power-on, U8(PB)-10 causes an interface reset to prevent unwanted states in the interface logic. Software resets, decoded by U13(PB)-6, may occur as a result of a momentary power interruption, a front panel request, or a system request.

605-27. Control Register

605-28. The following six "D" flip-flops compose the control register:

1. Interrupt enable U14(PB)-2 remains true, except during the power-on routine.

2. A service request (SRQ) to the system controller is initiated by U14(PB)-13.

3. The instrument controller being ready for data (RFD) is indicated by U16(PB)-1.

4. At the last data byte of a message to the system from the instrument controller, U11(PB)-13 goes true.

5. Data accepted (DAC) is sent and RFD is reset by U16(PB-13.

6. When the instrument is a talker, U11(PB)-2 is used to generate the data available (DAV) signal.

605-29. Status Register

605-30. The status register consists of U28 and part of U31. The instrument address decoded by U13(PB)-9 enables a status byte to be placed on the data bus (ID0-ID7). This status byte is defined as follows:

1. ID0: true from U28-7 when in the talk only mode.

2. ID1: true from U28-9 when remote enable (REN) from the system controller is false.

3. ID2: true from U28-9 when go to local (GTL) is true from the message decoder U5-4.

4. ID3: true from U28-3 for an interface message.

5. ID4: true from U31-3 for an interface message.

6. ID5: true from U31-5 to indicate a device dependent message.

7. ID6: true from U31-7 during the serial poll mode when the system controller is requesting status.

8. ID7: true from U31-9 when the system controller is requesting data from the instrument.

605-31. Message Decoder

605-32. Interface messages sent by the system controller on the data bus are decoded by U9, U5 and U8. The device dependent messages GET, SCD and GTL require the interface to be a listener before the instrument controller is interrupted. For group execute trigger (GET), U8-11 is true. For selected device clear (SDC), U8-10 is true. For go to local (GTL), U5-4 is true. The universal messages DCL and LLO are unique in that they cause the instrument controller to be interrupted when in local. For local lockout (LLO), U5-3 is true. For device clear (DCL), U5-10 is true. In addition, U8-4 goes true for the serial poll mode (SPE), and U8-3 is true for serial poll disable (SPD).

605-33. Mode Register

605-34. The mode register consists of the following four J-K flip-flops: U11-1 (clocks in MLA), U11-15 (clocks in MTA), U15-1 (true in remote mode) and U15-15 (true in serial poll mode).

605-35. Instrument Interrupts

605-36. Except during the power-on routine, interrupts are enabled by U14(PB)-2. The interrupt flip-flop may be clocked by the DAV signal through U4(PB)-4 and U4(PB)-3 or by U6(PB)-13 when the instrument is to be an active talker.

605-37. MAINTENANCE

605-38. Refer to Section 4 of the Instruction Manual for information on cleaning the module. The two pcb's are disassembled by removing the screws and standoffs fastening them together. To prevent damage to the electrical connectors, pull the boards straight apart.

605-39. PERFORMANCE TEST

605-40. Operation of the IEEE Interface can be verified by programming changes in range, output and mode, and by observing response data.

605-41. CALIBRATION

605-42. The IEEE Interface does not require calibration.

605-43. TROUBLESHOOTING

605-44. Troubleshooting the -05 IEEE Remote Interface Option consists of the tabular flow chart in Table 605-5. When a step in the flow chart is completed, check for a decision transfer, If no decision is required, perform the next step of the table in sequence.

605-45. Programming Instructions

605-46. Programming commands and instrument responses are explained in Table 605-6.

605-47. PARTS LIST

605-48. Table 605-7 provides a detailed parts list for the Interface PCB; Table 605-8 lists parts for the Piggyback PCB. Refer to Section 5 of this manual for ordering information.

Table 605-5. Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *Due to the speed and complexity of the data on the bus system, it is recommeded that the pcb be sent to the nearest Fluke Service Center for repair when a problem is isolated to the interface. The following table will be of some assistance when troubleshooting simpler problems; however, manu many problems will require the use of a Fluke Trendar, or similar logic board tester. The instrument must be connected through a bus network to a system controller, e.g., the Tektronix 4051 or HP 9825, to operate.*		
1	This test is based on the assumption that the DMM was checked and found opeational in local operation prior to installation of the IEEE Interface.		
2	Install the IEEE Interface Assembly in the instrument and apply power from the front panel switch.		
3	Is the front panel display correct?	6	4
4	If the display is blank, check the ACK circuit on the PB PCB.		
5	If the display is incorrect, check the input latches and output buffers on the Main PCB. Repair as required and return to step 2.		
6	Address the instrument on the IEEE bus with the applicable address. Does the instrument go into remote?	8	7
7	On the Main Board check the address lines through the Receiver/Driver, the address switches, the MLA circuitry, and the REN and DAV signals. On the Piggyback Board check the INT circuit. Repair as required then resume at step 2.		
8	Program an instruction from the remote controller. Is the output display as programmed?	10	9
9	Check the output latches and buffers, the UNL circuitry and the Receiver/Driver on the Main Board. Repair as required and return to step 8.		
10	Does the instrument respond to and "SRQ" from an Interrupt Ready or Error?	12	11
11	Check the SRQ line inand the Receiver/Driver on the Main Board and the status latches on the Piggyback Board. Repair as required then resume at step 10.		
12	Does the interface clear from the system controller?	14	13
13	Check the IFC input and the IFC circuit. Repair as required, then resume at step 12.		
14	Can the Front Panel be locked out from the system controller?	16	15
15	Check the LLO line and the decoder circuit. Repair as required then resume at step 14.		
16	Troubleshooting of the IEEE Interface, as applicable at this level, is complete.		

Table 605-6. Programming Instructions

The programming instructions in this table pertain to the 8500 Series Digital Multimeters with the IEEE-488 Interface (Option -05), the Bit Serial Interface (Option -06) or the Parallel Interface (Option -07) installed. Features and instructions unique to the DMM model or to the Interface used will be identified in the following manner:

1. 8500A or 8502A: the symbol ◆ will denote an explanation applicable to one DMM model only. The software version incorporated in the DMM may also be mentioned for further identification. To verify the software version incorporated in your instrument, observe the display indication at power on or reset. For example, in the 8502A, "HI-2.0.2" will appear in the display for models with software version 2.0.2.

2. -05, -06, or -07 Interface Options: the symbol ● will be used with a feature or instruction unique to a particular Interface.

INITIALIZATION

When power is applied, or the Reset character (*) is transmitted, the instrument assumes a preset default condition. This condition is defined by the following remote codes:

	REMOTE CODE	COMMAND
	V	Volts DC
	R4	1000V range
◆	S5 (8500A)	2^5 Samples per Reading
◆	S7 (8502A)	2^7 Samples per Reading
	F0	Fast Filter, Timeout Disabled (Panel Indicator OFF)
	X0	External Reference/Scaling Disabled
	P0	Offset Feature Disabled
	U0	Limits-Peak Value Storage Disabled
	T0	Single Reading Line Synchronous
	B0	Single Character ASCII Format
	D0	Front Panel Display Active
	L0	Deactivate Local Lockout
	J0	Deactivate Line Feed Suppression
	M0	Enable Cal Memory Factors
◆	Q0 (8502A)	Disable External Trigger
◆	W (8502A)	No Delay
●	Y0 (-06 Option only)	Echo mode off (Bit Serial IF)

In addition, the following instrument states are assumed at power on or Reset:

	Remote/Local	Local
	Offset	Zeroed
	V dc Zero	Zeroed or *
	Ohms Zero	Zeroed or *
	Cal Memory Factors	*
	Peak Values	Cleared
	Limits Values	Zeroed
	Ext. Ref/Scaling Values	1
●	8/16 Bit Mode (-07 Option only)	8 Bit

*Retained if Cal Memory Option -04 installed

Table 605-6. Programming Instructions (cont)

PROGRAM SEQUENCE

When equipped with a remote interface option, the instrument is programmed through a sequence of commands ("command string") that will determine range, function, reading rate, etc. Examples of 5 possible command strings are:

1. V A R 2 S 5 F ?
   - Execute, trigger and transmit
   - Slow filter, no time out
   - 2^5 samples/reading
   - 10 volt range
   - AC voltage

2. T D Y ?
   - Execute, trigger and transmit
   - Echo characters
   - Turn display off
   - Continuous line synchronized readings

3. K N U 6 . 3
   - Upper limit

   K N L 6 . 2 U ,
   - Execute
   - Enter limits mode
   - Lower limit

4. Z R , S 5 $
   - Clears command string to preceeding "," "?" or "@"
   - 2^5 samples/reading
   - Execute
   - Auto range
   - Ohms

5. % G 1 ?
   - Execute, trigger and transmit
   - Get status and transmit on trigger
   - Halt reading

Table 605-6. Programming Instructions (cont)

All command string characters transmitted via the remote interface must be ASCII 7-bit upper case characters. A command string is a sequence of 1 to 31 characters. Characters are classified as immediate, command or termination. The instrument may be placed in Remote mode by toggling the front panel REMOTE switch or by transmitting any character that the instrument will recognize from the remote controlling terminal.

- With the IEEE Interface installed, the REMOTE switch can only be used to select local mode if already in Remote.

REMOTE is the only front panel switch to remain active when in REMOTE mode; REMOTE may, however, be locked out by the local lockout command.

IMMEDIATE CHARACTERS

There are 5 immediate characters; each of these may be executed at any time and does not require a termination character.

*** Reset**

This immediate character will reset the instrument to the conditions described under INITIALIZATION.

- ◆ When transmitted, the reset character must not be followed by any other character for 3 seconds with the 8502A (2 seconds with the 8500A). Any carriage return or line feed following the reset character must be suppressed. The remote interface will be unable to accept programming characters during this time.

% Halt

The halt character is used to terminate the continuous mode and cause the instrument to wait for a command string. No other characters should precede the halt character if continuous mode is in effect. Upon receipt of the halt character, the transmission of readings is terminated immediately. The following trigger mode transitions will occur when halt is used:

From: Continuous Line Synchronous
To: Signal Reading Line Synchronous

From: Continuous Asynchronous
To: Single Reading Asynchronous

 # Go To Local - Lock Out Remote

- This character will command the instrument (Options -06 or -07 only) to enter local mode of operation and lock out the remote interface.
- The Remote mode may then be reentered by pressing the front panel REMOTE switch (for Option -06, -07). The Remote mode may not be reentered from the front panel when using the IEEE-488 Interface (Option -05).

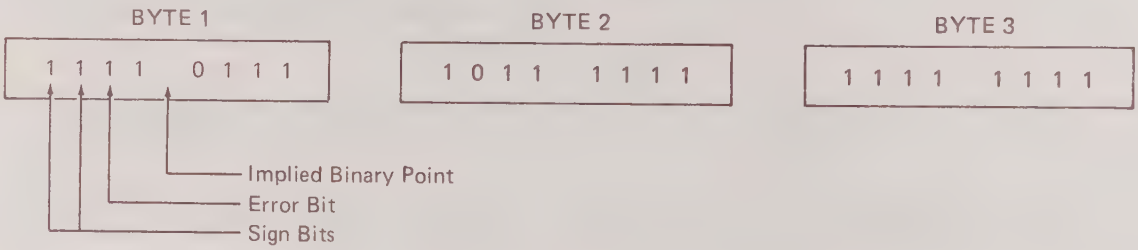
Table 605-6. Programming Instructions (cont)

#	**Go To Local-Lock Out Remote (cont)**	The state of the instrument, when changing from remote to local operation will be modified as follows: 1. Ohms fast mode will be ignored. ◆ 2. Scaling mode will not be in effect (8500A only). ◆ 3. If the high averaged samples per reading rate was in effect, the samples per reading will be set to 2^7 (8500A only). The state of the instrument when changing from local to remote operation will be modified as follows: 1. Ohms fast mode (Z1) and continuous reading mode will be resumed if the DMM was in either mode when place into local. 2. Any error that occurred during local operation will be stored and available for recall.
!	**High Speed Reading Mode**	● The "!" character can be used with the Parallel Interface (Option -07) (and with the IEEE-488 Interface Option -05 in the 8502A only). The High Speed Reading mode provides a shortened 3-byte binary two's complement format response representing the input to the DMM's A/D Converter. Speeds up to 500 readings per second are possible in this mode of operation. True readings can be computed from this response using range and function dependent factors (refer to Fluke Application Bulletin 25). The High Speed Reading mode is suited to systems with very fast processors, to use with stored readings, or to applications not requiring direct numeric conversions (e.g., zero crossings or large deviations from a nominal value). ◆ Use of the "!" character will place the DMM in the High Speed Reading mode and trigger the first reading. Subsequent readings can be triggered by sending the "?" character. In addition, for the 8502A equipped with the -08A Option, subsequent readings can be triggered by sending the TTL pulse with the External Triggering Mode ("Q" or "Q1"). The High Speed Reading mode can be aborted at any time by transmitting a character other than "?" when a reading is to be triggered. The character sent in this case will do nothing more than cause the DMM to exit the High Speed Reading mode.

Table 605-6. Programming Instructions (cont)

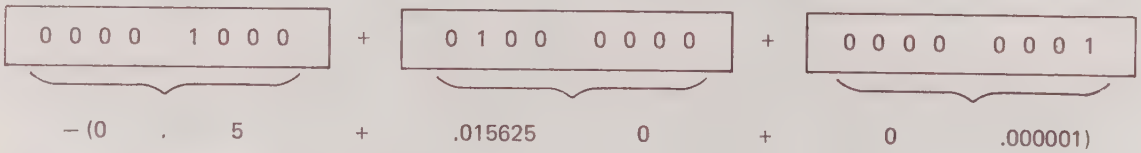
Voltage and Current Reading in "!"

The response data from the DMM will be in 3-byte format, as shown below, for each voltage or current reading. The first byte of this response contains sign and error bits, an implied binary point, and an implied scale factor of ten. Bytes 2 and 3 further define the reading. If the reading is negative, the sign bits will equal "1", and all three bytes must be two's complemented before conversion. If the error bit is equal to the complement of the sign bit, an error is defined.



In this example, the sign bits are "1" and the reading is negative. Since the complement of the sign bit does not equal the error bit ("1"), no error is defined.

To convert the response in this example, the two's complement must first be formed.



= 0.515626 X 10 (the implied scale factor)

Further conversion to calculate the true reading Rt necessitates multiplication of the A/D Converter reading (RAD) by the scale factor for the instrument's range and function.

$[R_t = R_{AD}$ X Scale Factor]

Ohms Readings in "!"

The procedure for measuring ohms in High Speed Reading mode is more complex. High Speed Ohms readings differ from Fast Ohms (Z1) readings; when using the "!" character, the DMM will not compute the true reading. This conversion must be performed by the user. Up to 500 readings a second are possible when using High Speed Ohms. Refer to OPERATING NOTES, provided with Option -05 and -07 for High Speed Ohms Reading procedures.

/ **8/16 Bit Toggle**

The "/" character is used to toggle between the 8-bit and the 16-bit mode. When this character is used to toggle from one mode to another, the immmediate and/or termination character must be placed in the least significant byte (LSB) of the programming word.

Table 605-6. Programming Instructions (cont)

TERMINATION CHARACTERS

Termination characters cause the execution of a command string. They are normally placed at the end of each programming statement.

$ Clear the Command String

● (Normally used only with the Bit-Serial Interface -06 Option.)

This character is used to erase an incorrect programming entry from the command string buffer, deleting all characters issued back to, but not including, the preceding termination character. A new command string is then needed to modify the state of the instrument.

, Execute the Command String

This character is used to cause the execution of the previous command string. The instrument will then be in the defined state only; the character will not trigger a reading or produce a response from the instrument. When programming a string of characters, it is recommended that the execute character be used at frequent intervals; if an error is made, the string need then be cleared only back to the last execute character. This execute character is also required if a command string longer than 31 characters is used.

? Execute the Command String and Trigger

This character will cause three actions: any previously entered command string will be executed, a reading will be taken, and that reading will be transmitted through the remote interface. If a command string was not entered immediately preceding this character, the instrument will take and transmit a reading in the last defined state.

An exception occurs when a command string containing a "Get" command has been entered; the instrument will then respond with the value or status that was requested by the command string (no reading will be triggered).

When issuing a program string terminated by the "?" character, the "CR" and/or "LF" delimiter characters should be, but do not have to be suppressed. If an error occurs during the reading, a single "0", followed by a "CR", will be transmitted. At this point, status should be requested to determine the cause of the error.

@ Execute, Trigger, and Interrupt when Ready

This character is used to trigger a reading and generate an interrupt when the reading is complete.

Table 605-6. Programming Instructions (cont)

[@] **Execute, Trigger, and Interrupt when Ready (cont)**

- To provide the interrupt, the Bit-Serial Interface (Option -06) and the Parallel Interface (Option -07) transmit a single "CR". The IEEE-488 Interface (Option -05) provides an interrupt by generating a service request (SRQ).

The reading triggered by the "@" character can be obtained by inserting a "G" (get) command in the following command string (terminated by a "?").

The "@" character and the IEEE-488 Bus command "Group Execute Trigger" perform the same function.

COMMAND CHARACTERS

Command characters are classified within the following five groups:

1. FUNCTION
2. RANGE
3. MODIFIERS
4. CONTROL
5. MEMORY

FUNCTION COMMAND CHARACTERS

There are 7 function command characters. Whenever one of these characters is used, the state of the instrument will be changed as follows:

RANGE	Auto
MODIFIERS	Offset, Scaling, Limits, Peaks modes are turned off; stored values for these modes are retained.
MEMORY, CONTROL	Unchanged

If a function is selected requiring an optional module which is not loaded, the function of the instrument will be undefined, and the error code will be set to 19.

[V] **DC Volts**

[V] [A] **AC Volts**

[C] **DC Coupled AC Volts**

[I] **DC Current**

[I] [A] **AC Current**

Table 605-6. Programming Instructions (cont)

Z **Ohms**

Z **1** **Fast Ohms**

The Z1 character will place the instrument into the ohms function and the fast ohms mode. In normal ohms operation, the unknown resistor value Rx is computed from the following measurements:

V1-V2: the voltage across an internal precision resistor (Rr)
V0: the voltage across the unknown resistor (Rx).

The value of Rx is then computed with Ohm's Law:

$$Rx = Rr \frac{V0}{V1\text{-}V2}$$

Fast Ohms mode differs in that the value of $\frac{Rr}{(V1\text{-}V2)}$ is stored as a constant. The instrument will the find Rx by measuring V0 and multiplying this constant. The constant will change with a function change, range change or overload condition.

NOTE

Fast ohms ("Z1") differs from HIGH SPEED READING ("!"). When using "!" for ohms measurement, Rx is not computed by the DMM.

RANGE COMMAND CHARACTERS

The nine range commands specify the following maximum values by function.

	DC VOLTS	VA or C AC VOLTS	I or IA DC or AC CURRENT	Z or Z1 OHMS
R	Auto	Auto	Auto	Auto
R **0**	312 mV	Auto	312 μA	31.25Ω
R **1**	2.5V	2.5V	2.5 mA	250Ω
R **2**	20V	20V	20 mA	2 kΩ
R **3**	160V	160V	160 mA	32 kΩ
R **4**	1200V	1000V	1.28A	256 kΩ
R **5**	Auto	Auto	Auto	4.096 MΩ
R **6**	Auto	Auto	Auto	32.768 MΩ
R **7**	Auto	Auto	Auto	262.144 MΩ

Table 605-6. Programming Instructions (cont)

MODIFIER COMMAND CHARACTERS

SAMPLES PER READING COMMAND CHARACTERS

The modifier command character "S" or "H" specifies the number of samples taken per reading. The times shown for these characters are approximate digitizing times per reading for 60 Hz line synchronous operation in dc volts, ac volts or current function.

S 0	2^0 = 1 Sample/Reading (4 ms)
S 1	2^1 = 2 Samples/Reading (8 ms)
S 2	2^2 = 4 Samples/Reading (17 ms)
S 3	2^3 = 8 Samples/Reading (33 ms)
S 4	2^4 = 16 Samples/Reading (67 ms)
S 5	2^5 = 32 Samples/Reading (134 ms)
S 6	2^6 = 64 Samples/Reading (267 ms)
S 7	2^7 = 128 Samples/Reading (534 ms)
H 0	2^8 = 256 Samples/Reading (1.1s)
H 1	2^9 = 512 Samples/Reading (2.1s)
H 2	2^{10} = 1,024 Samples/Reading (4.3s)
H 3	2^{11} = 2,048 Samples/Reading (8.5s)
H 4	2^{12} = 4,096 Samples/Reading (17.1s)
H 5	2^{13} = 8,192 Samples/Reading (34.1s)
H 6	2^{14} = 16,384 Samples/Reading (68.3s)
H 7	2^{15} = 32,768 Samples/Reading (137s)
H 8	2^{16} = 65,536 Samples/Reading (273s)
H 9	2^{17} = 131,072 Samples/Reading (546s)

Table 605-6. Programming Instructions (cont)

FILTER COMMAND CHARACTERS

The "F" character is used to specify the type of filtering and the enabling of a time-out (for the filter settling time). This time-out causes a delay between a trigger command received and the actual reading taken. In the continuous trigger modes, the time-out will occur before each reading is initiated. The following "F" modifier command characters are used:

F	**Slow filter, time-out disabled.**
F 0	**Fast filter, time-out disabled.**
F 1	**Bypass filter.**
F 2	**Slow filter, time-out enabled (approximately 500 ms).**
F 3	**Fast filter, time-out enabled (approximately 50 ms).**

TRIGGER COMMAND CHARACTERS

The "T" characters specify the instrument's trigger mode. These characters determine whether samples taken are line synchronous (every 4 or 5 ms) or line asynchronous (approximately every 1.7 ms), whether single or continuous readings are to be taken.

T	**Continuous reading mode/line synchronized.**
T 0	**Single reading mode/line synchronized.**
T 1	**Continuous reading mode/line asynchronous.**
T 2	**Single reading mode/line asynchronous.**

NOTE

When line asynchronous modes are selected, the display will be turned off to save time; the front panel switches are then ignored.

- When in the continuous mode, any character (except "%" HALT) will be ignored by the instrument (8502A).

When in the Single Reading mode ("T0" or "T2"),and IEEE Group Execute Trigger command, a "?" or "@" character, or a TTL trigger (for the 8502A-08A) must be sent for each reading.

With the Continuous Reading mode ("T" or "T1"), use of the "GET" command, "?", "@" or a TTL trigger will start continuous readings.

Table 605-6. Programming Instructions (cont)

When each reading is accepted by the instrument controller, the next reading will be started. An exception to this sequence occurs in the "J1" Suppress Output mode; the next reading will now be taken immediately, without waiting for the output to the controller.

NOTE

The front panel display does not update in this mode unless the controller asks for a reading.

Use of the "%" character will halt the Continuous Reading mode and cycle the unit back to the Single Reading mode.

OFFSET COMMAND CHARACTERS

The "P" command characters specify whether an offset will be subtracted from a reading. The offset value may be entered by storing either a previous reading or a numerically entered offset.

◆ When storing readings, the 8500A will store the unprocessed reading, and the 8502A will store the displayed value.

Offset values may range from $\pm 1 \times 10^{9}$ to $\pm 1 \times 10^{-9}$ (including 0.0).

P **Offset subtracted (ON).**

P 0 **Offset not subtracted (OFF).**

EXTERNAL REFERENCE AND SCALING COMMAND CHARACTERS

The "X" command characters select External Reference or Scaling mode. Either mode is valid for any function and range. In External Reference mode, readings are divided by the signed magnitude of the external reference voltage. In Scaling mode, readings are divided by a numerically entered scale factor or by a previously read value.

X **External Reference On, Scaling Off**

The "X" External Reference mode uses the external reference voltage (Vxref) to divide the measured voltage. Vxref is measured during each reading cycle.

◆ Minimum Vxref = ±0.0001V or the input divided by the maximum display with the volts range, whichever is greater (8500A only).

◆ For the 8502A, the minimum Vxref is the input divided by 10^{9}.

Maximum Vxref = ±40V between Ext Ref Hi and Lo terminals, providing neither terminal is greater than ±20V relative to the Sense Lo or Ohms Guard Terminals.

Table 605-6. Programming Instructions (cont)

X 0	**External Reference Off, Scaling Off**
X 1	**External Reference Off, Scaling On**

The "X1" Scaling mode will divide all readings by a previously taken external reference voltage or by a previously entered numeric scale factor. The read valued may not be used as a scaling factor.

- Minimum scaling factor = the same as the minimum Vxref, for the 8500A.
- For the 8502A minimum = 10^{-9}. Factors less than this will be set to 0, which is not a valid scale factor.

Maximum scaling factor = ±100 (8500A), or Input/Max Scale factor $<10^{-9}$ (8502A).

NOTE

The "X" and "X1" modes are mutually exclusive.

LIMITS AND PEAKS COMMAND CHARACTERS

The "U" command characters specify selection of Limits or Peaks modes.

U	**Limits Testing On**

When this command character is sent, each instrument reading is compared to upper and lower limits. Limit values must be entered separately with a keep command (refer to KEEP COMMAND CHARACTERS). The output format from the instrument (when given a "G" command) is as follows:

"0" is transmitted for a reading within limits.

"1" is transmitted for a reading greater than the upper limit.

"-1" is transmitted for a reading less than the lower limit.

"2" is transmitted if an error occurs (e.g., overranging).

U 0	**Disable Limits and Peak Mode(s)**
U 1	**Save Highest and Lowest Values (Peaks On)**

Previous peak values are erased from memory whenever the "U1" command character is programmed.

Table 605-6. Programming Instructions (cont)

U 1	**Save Highest and Lowest Values (Peaks On) (cont)**	◆ For the 8500A, storage of limit and peak values are mutually exclusive. For the 8502A, limit and peak values can be held in memory simultaneously.

NOTE

Limits are applied after all other modifier operations (Scaling, Offset, etc.) have been performed.

CONTROL COMMAND CHARACTERS

Output Format

The "B" characters activate binary or ASCII output format.

B	**Single Byte Binary Format**	
B 0	**Single Byte ASCII Format**	
● B 1	**Binary 16-Bit Parallel**	"B1","B2" used with Paralled ASCII Interface (Option -07) only.
● B 2	**16-Bit Parallel**	

The front panel DMM display is turned on when the ASCII mode is entered and off when the binary mode is entered.

The Binary Output Format

The binary output format consists of five bytes. The first four bytes comprise a 32-bit binary two's complement fixed point number. An implied binary point for this number is located between the first and second bytes. The first 8-bit byte thus serves as the integer portion. The 24 bits of the next 3 bytes serve as the binary fraction. Additionally, since this format cannot be used to hold the entire range of possible values for the DMM, a fifth byte is used as an exponent. This exponent is a two's complement binary number representing the decimal exponent of the binary fixed point number defined by the first 4 bytes. An exception occurs in Limits testing; the response will then be single byte binary two's complement number.

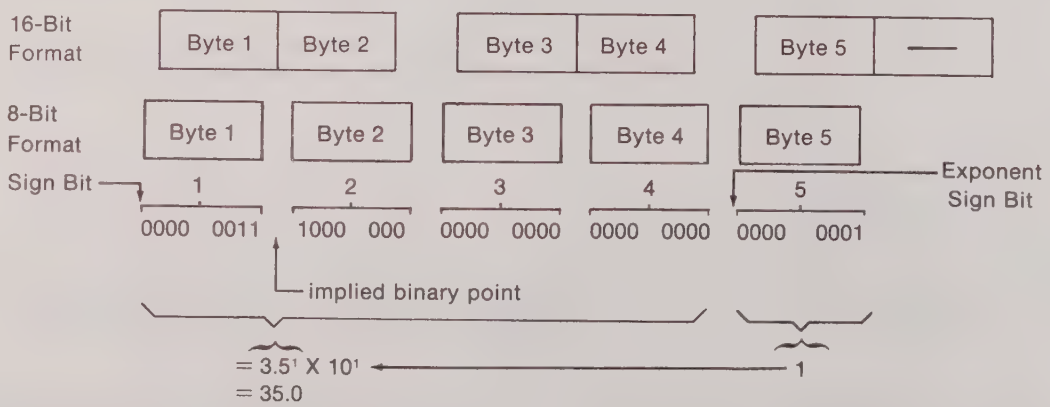


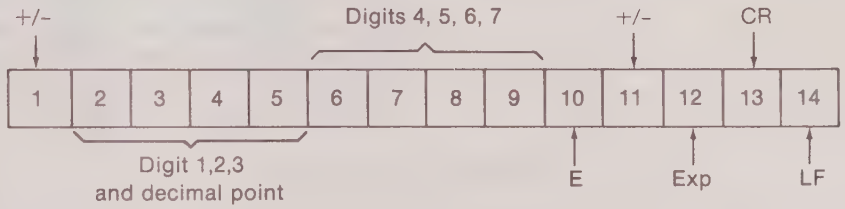
Table 605-6. Programming Instructions (cont)

NOTE

In dc volts and ac volts, the exponent is always 1. In dc and ac current, the exponent is always –2. The exponent is range dependent in ohms function (1 for ohm ranges, 4 for kohm ranges, and 7 for Mohm ranges).

Errors will be indicated by 5 bytes of 0.

ASCII Data Output Format



The seventh digit in the ASCII format corresponds to the "Cal" or HIRES digit of the front panel display. In some ranges and functions (e.g., 100 mV dc) this digit is permanently zeroed since it exceeds the resolution of the instrument). (When in the "Cal" or HIRES mode, the front panel will display the value of the reading rounded to six significant digits.)

DISPLAY CONTROL

The "D" command characters turn the DMM front panel display on or off.

D **Display Off**

D 0 **Display On**

When the "D0" command is used, the instrument will no longer interrogate any of the front panel switches (local lockout). The display will be turned On when the ASCII output format is commanded.

LOCAL LOCKOUT CONTROL

The "L" command characters select the local lockout condition, in which the display remains activated while none of the front panel switches affect the instrument.

L **Local Lockout On**

L 0 **Local Lockout Off**

ECHO COMMAND CHARACTERS
● (used with Bit Serial Option -06 only)

Y **ECHO ON (Full-Duplex)**

Y 0 **ECHO OFF (Half-Duplex)**

Table 605-6. Programming Instructions (cont)

LINE FEED CONTROL COMMAND CHARACTERS

J	**Suppress Line Feed Character**	This character suppresses the LF character normally sent at the end of a response line.
J 0	**Transmit Line Feed Character**	This character disables the "J" character; the "LF" character will be sent.
J 1	**Suppress Output of Readings**	◆ In the 8500A, use of J1 will suppress all output from the DMM. In the 8502A, use of J1 will suppress output with the following exceptions: Service Request (SRQ), status, recalled values. While in the J1 mode, use of the recall command "G ?" will retrieve a reading. Use of "J" or "J0" will exit the "J1" mode.

CALIBRATION CONSTANT

When the Calibration Memory (Option -04) module is installed, the "M" character will inhibit the adjustment of readings by the Calibration Memory correction factor. A slight increase in the speed of readings will result.

M	**Inhibit Calibration Memory Factors**
M 0	**Enable Calibration Memory Factors**

TRIGGER COMMAND CHARACTERS

◆ This set of command characters is available for the 8502A with the Isolator Option -08A.

Q	**Activate External Triggering Mode, Interrupt when Ready**	This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ).
Q 0	**Deactivate External Triggering Mode**	
Q 1	**Activate External Triggering Mode, Transmit when Ready**	The Q1 character also enables External Triggering mode. Any external TTL trigger initiates and transmits a reading.

NOTE

The "?" and "@" characters remain operative during External Triggering.

Table 605-6. Programming Instructions (cont)

◆ EXTERNAL TRIGGER DELAY COMMAND CHARACTERS
(-08A with 8502A only)

The "W" command characters select the amount of delay between the external trigger signal and the initiation of the reading.

W	No Delay
W 0	2.083 ms
W 1	4.166 ms
W 2	8.332 ms
W 3	16.66 ms
W 4	33.33 ms
W 5	66.66 ms
W 6	133.3 ms
W 7	266.6 ms
W 8	533.2 ms
W 9	1.066s
W 1 0	2.133s
W 1 1	4.266s
W 1 2	8.532s
W 1 3	17.06s
W 1 4	34.13s
W 1 5	68.26s

Table 605-6. Programming Instructions (cont)

MEMORY COMMAND CHARACTERS

STORE

The "K" (Keep) command characters specify the storing of a reading or numeric entry.

[K] **Store Last Reading as Offset**

◆ The 8500A will store the unprocessed reading, whereas the 8502A will store the displayed reading.

[K] [0] **Store Last Voltage Taken as VDC Zero (on R0 Only)**

[K] [1] **Store Last Reading as Ohms Zero (on R0 Only)**

[K] [N] [P] **Store Numeric Value Following as Offset**

[K] [N] [X] **Store Numeric Value Following as Scaling Factor**
(Note: The read value may not be stored as a Scaling Factor.)

[K] [N] [U] **Store Numeric Value Following as Upper Limit**

[K] [N] [L] **Store Numeric Value Following as Lower Limit**

Offsets, Scaling Factors, Upper and Lower Limits may be entered via the "KN" command characters, followed by one of the modifier characters "P", "X", "U" or "L" and the numeric value (on ASCII string of numeric characters, and optional sign, decimal point and signed decimal exponent digit in "E" notation).

Examples of legal numeric strings are:

[K] [N] [P] [1] [0]
Keep Numeric offset of 10.0

[K] [N] [X] [1] [0] [.] [3] [E] [-] [1]
Keep numeric scaling factor of 10.3×10^{-1} or 1.03

[K] [N] [U] [7] [.] [6] [E] [4]
Keep numeric upper limit of 7.6×10^{4}

[K] [N] [L] [-] [1] [2] [3] [.] [4] [5] [6] [E] [+] [0]
Keep numeric lower limit of -123.456

Table 605-6. Programming Instructions (cont)

An example of an illegal numeric string is:

K	N	X	2	.	0	E	-	1	3

Exponent is limited to one signed integer digit, in this case the exponent would be -1 and the "3" would be ignored.

NOTE

Numeric entries are limited to the maximum display value. These values are:

+1.00000 E +9 to +1.00000 E -9, and -1.00000 E -9 to -1.00000 E +9

Numbers less the ±1.00000 E -9 are treated as zero.

RECALL

The "G" (Get) command characters specify the recall of a reading, a numeric entry or a status. Each "Get" command must be followed by a "?" termination character. The following memory "Get" commands may be used:

G	**Recall Previous Reading and Send on Next Trigger**
G 0	**Recall DC Zero and Send on Next Trigger**
G 1	**Recall Status and Send on Next Trigger**

Status information from the DMM may be obtained with the command character "G1?". The status response will be returned in the following seven character format.

Error Codes

1	2					

Characters 1 and 2 define error code status. Each error code contains two digits: those codes with a zero for the first digit are related to remote operation only. All other codes contain the same second digit as the DMM's front panel error codes.

- 00 No Error
- 06 System Error
- 07 Illegal Numeric Entry
- 08 Remote Command String Error
- 09 Remote Overrange
- 10 V DC Zero/Ohms Zero Error
- ◆ 11 Offset Error (8500A) Store during Overrange (8502A)

Table 605-6. Programming Instructions (cont)

Error Codes (cont)

12 Filter Module Faulty or not installed
13 DC Signal Conditioner Module Faulty or not installed
14 Excessive voltage present at terminals for Ohms/Current Measurement
15 Fast A/D Converter Faulty or not installed
16 Numeric Display Overflow
17 Magnitude of External Reference Input >20V
18 Controller Module Faulty
19 Function Module selected not installed

Range Codes

		3				

The third character of the status response contains the following range information:

0 100 mV dc, 100 μA, 10Ω
1 1V dc, 1V ac, 1 mA, 100Ω
2 10V dc, 10V ac, 10 mA, 1kΩ
3 100V dc, 100V ac, 100 mA, 10 kΩ
4 1000V dc, 1000V ac, 1A, 100 kΩ
5 1 MΩ
6 10 MΩ
7 100 MΩ

Sample Codes

			4			

The fourth status response character contains sample information identified by the following codes:

0 1 Sample per Reading
1 2 Samples per Reading
2 4 Samples per Reading
3 8 Samples per Reading
4 16 Samples per Reading
5 32 Samples per Reading
6 64 Samples per Reading
7 128 Samples per Reading or Greater

Function Codes

				5	<CR>	<LF>

The fifth response character identifies function:

0 DC Volts
1 AC Volts
2 DC Amps
3 AC Amps
4 Ohms
5 DC Coupled AC Volts
7 Function Not Defined

Table 605-6. Programming Instructions (cont)

G N P	Recall Offset and Send on Next Trigger
◆ G N X	Recall External Ref or Scaling Factor and Send on Next Trigger (8500A) Recall Scaling Factor (8502A)
◆ G N R	Recall External Reference Factor and Send on Next Trigger (8502A)
G N U	Recall Upper and Send on Next Trigger
G N L	Recall Lower Limit and Send on Next Trigger

NOTE

The instrument will replay to "GNU" or "GNL" by transmitting the stored limit value.

G N Q	Recall Lowest (Peak) Value Found and Send on Next Trigger
G N W	Recall Highest (Peak) Value Found and Send on Next Trigger

Table 605-7. IEEE-488 Interface Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Ⓐ IEEE, 488-1975 INTERFACE ASSY --FIGURE 605-2 (MIS-4172T)	ORDER	BY	OPTION MIS-05	1		
	IEEE, 488-1975 PIGGY BACK PCB ASSY --FIGURE 605-4 (MIS-4072)	PART	OF	OPTION MIS-05			
C1	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	2		
C2	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	REF		
C3	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015KA1	1		
C4	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	5		
C5	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	REF		
C6	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	REF		
C7	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	REF		
C8	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	REF		
C9	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
CR1	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	1	1	
H1	COIL, SPRING	424465	83553	C0120-014-0380	1		
H2	LOCKWASHER, SPLIT, 8-32	111070	89536	111070	2		
H3	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
H4	SCREW, CONN MTG, (USE ON J3)	429472	89536	429472	2		
J2	POST, CONTACT	447813	22526	65501-136	3		
J3	CONN, CABLE, 24-PIN, MODIFIED	441337	02660	57-20240-14	1		
MP1	BAG, ANTI-STATIC (NOT SHOWN)	453530	89536	453530	1		
MP2	CASE HALF (NOT SHOWN)	402990	89536	402990	1		
MP3	CASE MODULE, MODIFIED (NOT SHOWN)	456079	89536	456079	1		
MP4	COVER, MODULE CASE (NOT SHOWN)	402974	89536	402974	1		
MP5	DECAL, CAUTION (NOT SHOWN)	454504	89536	454504	1		
MP6	DECAL, IEEE (NOT SHOWN)	413518	89536	413518	1		
MP7	GUARD, REAR (NOT SHOWN)	383364	89536	383364	1		
MP8	SHIELD, COVER (NOT SHOWN)	441022	89536	441022	1		
MP9	IEEE INTERFACE (NOT SHOWN)	383596	89536	383596	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
R1	RES, COMP, 18K +/-5%, 1/4W	148122	01121	CB1835	1		
R2	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	1		
R3	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	1		
R4	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	1		
R5	RES, COMP, 15K +/-5%, 1/4W	148114	01121	CB1535	1		
S1	SWITCH, MODULE SPDT, 5-POS.	417766	00779	435470-4	1	1	
S2	SWITCH, SLIDE, SPDT	417287	95146	MSS-1040-1	1	1	
U1	Ⓐ IC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U2	Ⓐ IC, COS/MOS, DUAL, 4-INPUT, NOR GATES	363820	02735	CD4002AE	1	1	
U3	IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	3	1	
U4	Ⓐ IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	2	1	
U5	Ⓐ IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	3	1	
U6	Ⓐ IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	REF		
U7	Ⓐ IC, COS/MOS, TRIPLE, 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U8	Ⓐ IC, COS/MOS, QUAD, 2-INPUT, NOR GATES	355172	02735	CD4001AE	REF		
U9	Ⓐ IC, C-MOS, DCDR/MULTIPLEXER	408369	04713	MC14556CP	1	1	
U10	Ⓐ IC, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	1	1	
U11	Ⓐ IC, COS/MOS, DUAL JK MASTER FLIP-FLOP	355230	02735	CD4027AE	2	1	
U12	Ⓐ IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U13	Ⓐ IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	

Table 605-7. IEEE-488 Interface Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U14	Ⓢ IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U15	Ⓢ IC, COS/MOS, DUAL, JK MASTER FLIP-FLOP	355230	02735	CD4027AE	REF		
U16	Ⓢ IC, C-MOS, QUAD, 2-INPUT, NAND	404632	02735	CD4093BE	1	1	
U17	Ⓢ IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	REF		
U18	Ⓢ IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U19	Ⓢ IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	REF		
U20	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	4	1	
U21	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U22	Ⓢ IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE	2	1	
U24	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U25	Ⓢ IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE	REF		
U26	IC, COS/MOS, QUAD, LOCKED D LATCH	355149	02735	CD4042AE	2	1	
U27	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U28	Ⓢ IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	3	1	
U29	Ⓢ IC, COS/MOS, QUAD, LOCKED D LATCH	355149	02735	CD4042AE	REF		
U30	Ⓢ IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	REF		
U31	Ⓢ IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	REF		
U32	IC, TTL, QUAD, 2-INPUT NAND GATES	393033	01295	SN74LS00N	1	1	
U33	RES. NETWORK, 4.7K	412916	89536	412916	2	1	
U34	RES. NETWORK, 4.7K	412916	89536	412916	REF		

Table 605-8. IEEE-488 Piggy Back Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Ⓟ IEEE-488-1975 PIGGY BACK PCB ASSEMBLY --FIGURE 605-4 (MIS-4072)	PART	OF	OPTION MIS-05	1		
C1	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	2		
C2	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
C3	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	1		
C4	CAP, MICA 270 PF +/-5%, 500V	148452	72136	DM15F271J	REF		
CR1	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	1	1	
H1	WASHER, FLAT, S/S 1/4 INCH	200980	86928	5710-65-16	1		
H2	WASHER, INT LOCK, 1/4 INCH	110817	73734	1308	1		
P2	CONNECTOR, SOCKET, 4-PIN	417311	20447	SS-109-1-04	5		
P2-1	--CONNECTOR, SOCKET, 12-PIN	417733	20447	SS-109-1-12	3		
P4	BINDING POST	441741	89536	441741	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
Q2	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	3		
R2	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	2		
R3	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	2		
R4	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	REF		
R5	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	REF		
R6	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	REF		
R7	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	REF		
R8	RES, COMP, 15K +/-5%, 1/4W	148114	01121	CB1535	1		
R9	RES, SELECTED						
U1	Ⓟ IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	4	1	
U2	Ⓟ IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	2	1	
U3	Ⓟ IC, C-MOS, QUAD, 2-INPUT NAND GATE	404632	02735	CD4093BE	1	1	
U4	Ⓟ IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U5	Ⓟ IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	
U6	Ⓟ IC, COS/MOS, DUAL, 4-INPUT NOR GATES	363820	02735	CD4002AE	1	1	
U7	Ⓟ IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U8	Ⓟ IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	2	1	
U9	Ⓟ IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	REF		
U10	Ⓟ IC, C-MOS, HEX INVERTER BUFFERS	381848	02735	CD4049AE	1	1	
U11	Ⓟ IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U12	Ⓟ IC, C-MOS, TRIPLE 3-INPUT AND GATES	408807	02735	CD4073BE	1	1	
U13	Ⓟ IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U14	Ⓟ IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U16	Ⓟ IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		

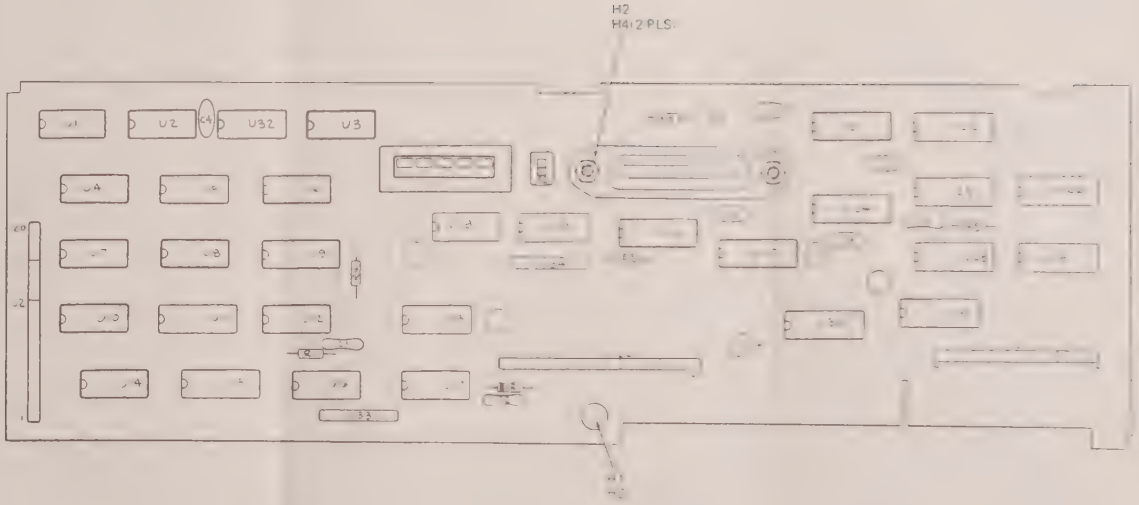


Figure 605-2. IEEE-488 Interface Assembly

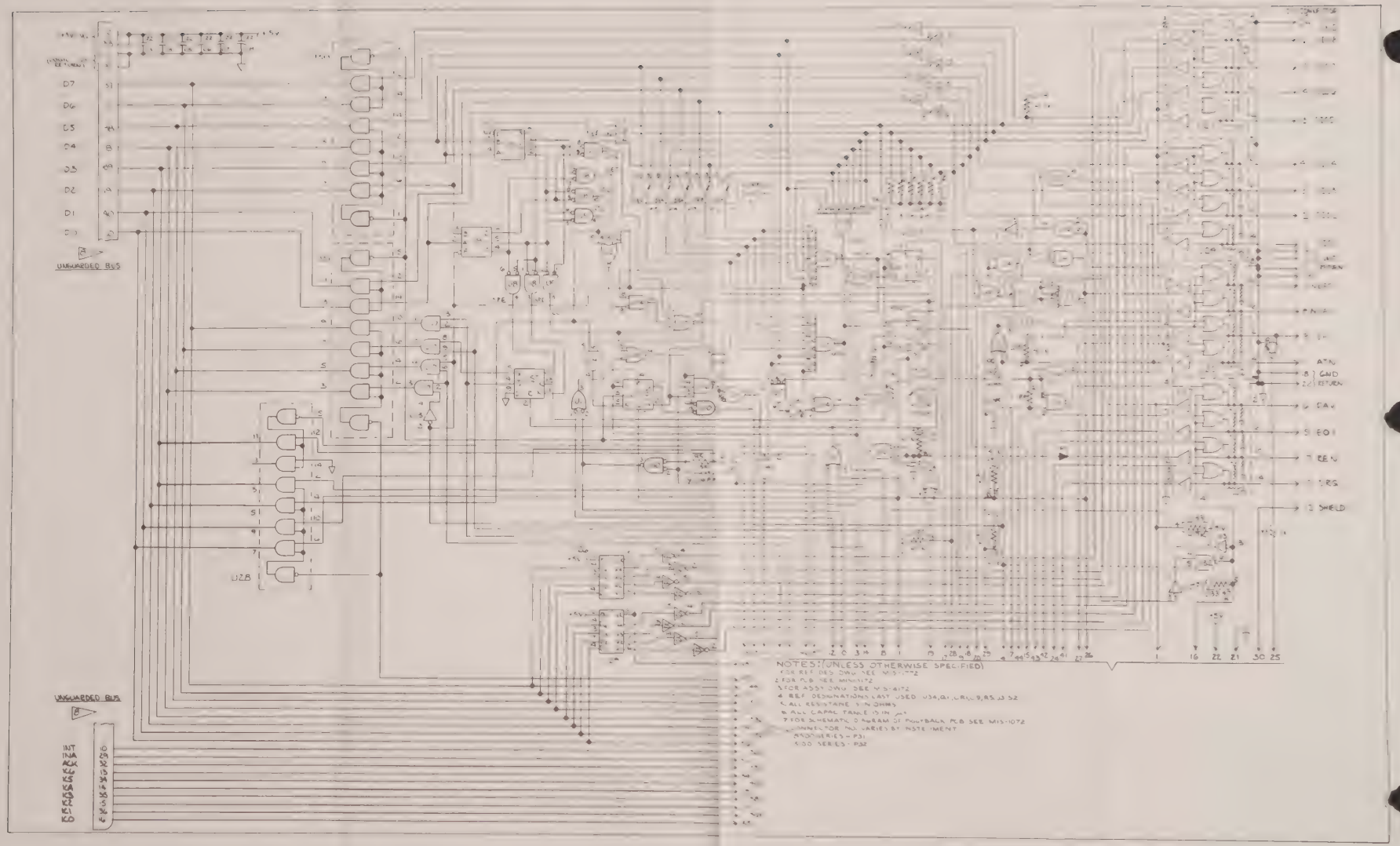


Figure 605-2. IEEE-488 Interface Assembly (cont)

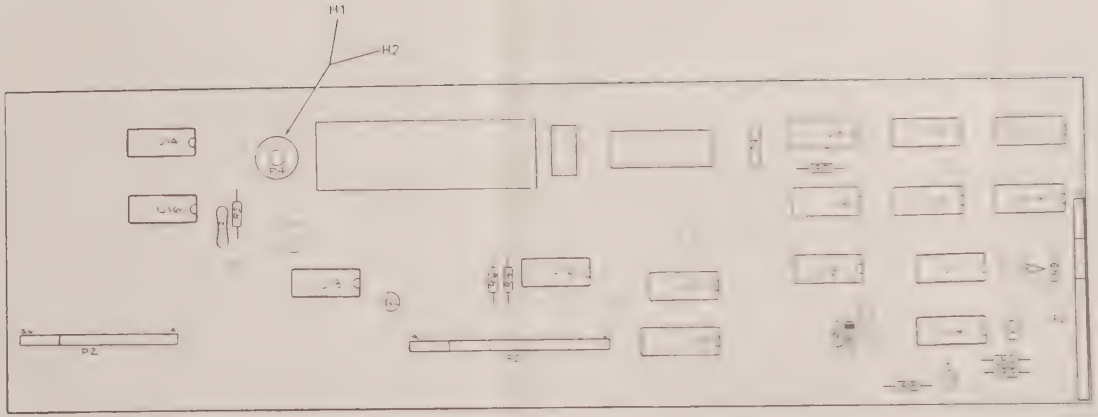


Figure 605-3. IEEE-488 Piggy Back Assembly

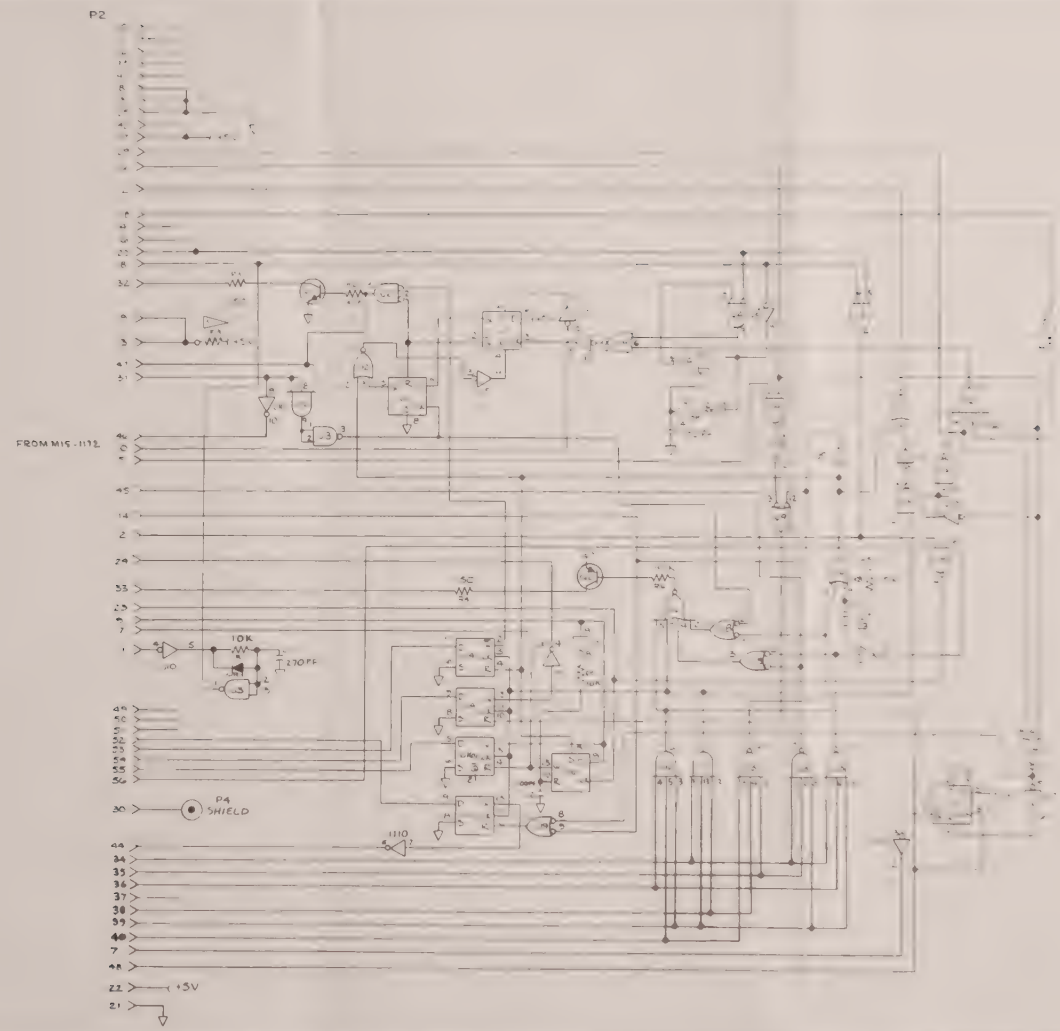


Figure 605-3. IEEE-488 Piggy Back Assembly (cont)

Option -06
Bit Serial Interface

606-1. INTRODUCTION

606-2. The Bit Serial Asynchronous Interface provides remote programming capability in applications where speed is not a critical factor. Switch selectable baud rates, stop bits, and current requirements permit maximum flexibility.

606-3. SPECIFICATIONS

606-4. The Bit Serial Asynchronous Interface meets or exceeds the requirements for data transmission and reception of EIA Standard RS-232B or C, MIL-STD-188B, CCITT V24 and 20 mA current loop. Specifications are as follows:

Input Format	Byte Serial, 8-bit parallel.
Timing Format	Asynchronous.
Output Format	Bit Serial.
Baud Rates	50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800 and 9600.
Operating Power	Derived from the DMM.
Operating Temperature	0° to 50°C.

606-5. INSTALLATION

606-6. The Bit Serial Interface is easily installed as a module in the 8500 series DMM. Use the following installation procedure:

1. On the DMM, press power OFF and remove the line power cord.

2. Remove the DMM's top cover.

3. The Interface module fits in the rear slot, bus connector and address switches facing to the rear. Slide the module vertically between the module guides, and press firmly into place.

NOTE

Make sure the leaf spring, attached to one-half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

4. If installed, remove the Interconnect PCB from slot K. This slot can be identified as the only slot with connectors on the analog and digital bus lines. To remove the Interconnect PCB, grasp the board at both ends, and pull up. An end-to-end rocking motion may be necessary to free the PCB from its connectors.

5. The Isolator module must be installed in slot K whenever a remote interface (Option -05, -06 or -07) is used in the DMM.

NOTE

Use Isolator -08 with the 8500A; Isolator -08A must be used with the 8502A.

6. Replace the DMM's top cover.

606-7. GENERAL

606-8. EIA Standard RS-232-C provides the electronics industry with the ground rules necessary for independent manufacturers to design and produce both data terminal and data communication equipment that conforms to a common interface requirement. As a result, a data communications system can be formed by connecting an RS-232-C data terminal (such as the 8502A) to an RS-232-C data communications peripheral (such as a TTY, MODEM, computer, etc.). This works fine on paper. However, in practice the user must be aware of the subtleties of serial binary data interchange to ensure that any two pieces of RS-232-C equipment will be compatible. For example, the two instruments must share

at least one of the features from each of the following characteristics.

1. Timing Format - Synchronous or Asynchronous.
2. Transmission Mode - Simplex, half-duplex, or full duplex.
3. Baud Rate (bits per second) - 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600.
4. Bits per character - 5, 6, 7, 8.
5. Parity Bit - Odd, even, high, low, not used.
6. Data Interface Levels - EIA or 20 mA current loop.

606-9. Timing formats conforming to both synchronous and asynchronous operation are shown in Figure 617-1. In asynchronous operation each character is bracketed by both start and stop bits. These bits separate the characters and synchronize both the transmission and receipt of data. When data is not being sent the data line is held high. In synchronous operation a sync character is sent prior to each data stream (a data stream usually consists of a block of characters). When the line is idle, a fill or sync character is continuously transmitted.

606-10. Transmission mode is an overall system requirement. It defines the communication ability of both instruments in the system configuration. Simplex indicates data transmission in one direction only. Half-duplex permits two way communication, but not simultaneously. Simultaneous transmission of data in both directions defines the full duplex system. Obviously, an instrument capable of full duplex operation can be downgraded to simplex operation. However, the reverse is not possible without degrading the system capability.

606-11. Baud rate is usually selectable on the RS-232-C Interface. If it is not, the manufacturer usually offers a choice when the instrument is purchased.

606-12. Character format (bits per character and parity) is somewhat flexible between instruments. Investigate the requirement of both instruments before committing either to a system configuration.

606-13. Data interface levels can occur as either EIA voltage levels or as a 20 mA current loop. At times an interface offers both simultaneously. The 20 mA current loop is used almost exclusively for teletypewriter, or paper tape punch/reader interface. EIA voltage levels are: 1 or OFF = –15 to –3V dc, 0 or ON = +3 to +15V dc.

606-14. OPERATING FEATURES

606-15. Attached to the PCB and accessible through a port on the rear panel (Figure 606-1) are a standard specified connector and a switch module with eight micro-switches. The connector is standard for the RS-232 Interface and is specified by the standard document. The eight switches control the operating modes of the interface and the BAUD rate. The modes selected by the switches are shown in Table 606-1 and Table 606-2. The selection of Odd or Even parity with switch 8 is applicable only if the parity feature has been selected using the jumpers described below.

606-16. The interface is shipped configured for an eight bit character without parity. Selection of parity and five, six or seven bit characters can be accomplished by installing jumpers into the PCB as shown in Table 606-3.

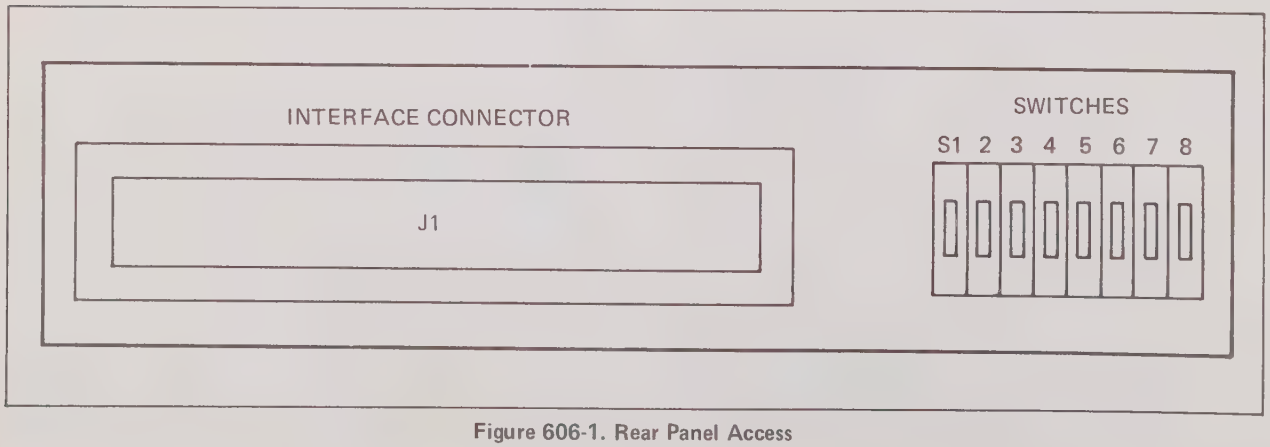


Figure 606-1. Rear Panel Access

Table 606-1. Mode Selection

SW#	SELECTION	SW ON	SW OFF
S1	Current Loop/RS232	Current	RS232
S2	RS232B/RS232C	RS232B	RS232C
S3	Stop Bits	1 Bit	2 Bits
S4	Baud Rate	*	*
S5	Baud Rate	*	*
S6	Baud Rate	*	*
S7	Baud Rate	*	*
S8	Parity	Odd	Even

* Defined in Table 606-2

Table 606-2. Baud Rate Selection

COUNT	S4	S5	S6	S7	BAUD RATE
0	OFF	OFF	OFF	OFF	110
1	OFF	OFF	OFF	ON	150
2	OFF	OFF	ON	OFF	300
3	OFF	OFF	ON	ON	2400
4	OFF	ON	OFF	OFF	1200
5	OFF	ON	OFF	ON	1800
6	OFF	ON	ON	OFF	4800
7	OFF	ON	ON	ON	9600
8	ON	OFF	OFF	OFF	2400
9	ON	OFF	OFF	ON	600
10	ON	OFF	ON	OFF	200
11	ON	OFF	ON	ON	134.5
12	ON	ON	OFF	OFF	75
13	ON	ON	OFF	ON	50

Table 606-3. Jumper Arrangements

	JUMPER #1 INSTALLED	JUMPER #2 INSTALLED	JUMPER #3 INSTALLED
Bit 5	Yes	Yes	N/A
Bit 6	No	Yes	N/A
Bit 7	Yes	No	N/A
Bit 8	No	No	N/A
Parity	N/A	N/A	Yes
No Parity	N/A	N/A	No

606-17. THEORY OF OPERATION

606-18. General

606-19. The bit serial interface alters and transmits data between the eight bit (byte) parallel format used on the instrument bus and the bit serial format of the system bus. As shown on the schematic, data inputs from either the system bus or the instrument bus are latched into universal asynchronous receiver transmitter (UART) U9, which is driven by a progammable clock (U3) set at the selected baud rate. Data in the Instrument Bus (ID0-ID7) is latched into the UART on DB1 through DB8 and output from the UART to the instrument bus on RD1 through RD8. Four separate functions are decoded from the control lines, and the receipt of any one generates a common acknowledgement signal (ACK). An interrupt function can be generated to notify the instrument controller the received data is available, allowing polled or interrupt control of the interface.

606-20. Functions

606-21. An address of IC0, IC4 and IC6 high with the remaining lines low generates the STATIN function. This generates ACK and enables the tri-state transmitters on the ID0-ID3 lines so that DA (received data available at RD1-RD8), OR (overrun; i.e., a new character received prior to final transmission of the previous character), RVMT (transmitter buffer empty and ready for the next character) and/or FE (framing error; i.e., no stop bit with received character) can be placed on the data lines.

606-22. The DATIN function (IC1, IC4, IC6 only high) strobes the RDE and RDA input to the UART. The UART is enabled to place data on the instrument bus by RDE and to receive another serial character from the system bus by RDA.

606-23. With IC2, IC4 and IC5 high, COUT is decoded to reset the UART and clock U5-3. If ID7 is high with COUT, the interrupt capability is disabled by enabling the reset at U5-10. This action prevents an interrupt signal to the instrument controller until removed. If ID8 is low, the interrupt circuitry is enabled.

606-24. DATOUT is decoded from IC3, IC4 and IC6 high, to strobe the DS input to the UART. The rising edge of DS initiates serial transmission of the character from SO onto the system bus. It is available at both J1-2 for RS-232 and J1-11 for the 20 mA current loop, for the users selection.

606-25. Interrupt

606-26. When DA (received data available) goes high, an interrupt is generated (unless it has been disabled by the COUT function) for a low at INT. The instrument

controller responds with an INA, generating an ACK and enabling U8-15 to pass the output of the interrupt flip-flop to the instrument controller for interrupt vectoring. The removal of INA by the instrument controller causes the Interrupt flip-flop to reset itself and prepare the circuit for the next interrupt.

606-27. MAINTENANCE

606-28. Refer to Section 4 of the Instruction Manual for information on module disassembly and cleaning.

606-29. PERFORMANCE TEST

606-30. Operation of the Bit Serial Interface may be verified by programming changes in range, output and mode, and by observing response data.

606-31. CALIBRATION

606-32. The Bit Serial Interface does not require calibration.

606-33. TROUBLESHOOTING

606-34. Troubleshooting for the -06 Bit Serial Asynchronous Remote Interface Option consists of the tabular flow chart in Table 606-4. When a step in the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

606-35. PROGRAMMING INSTRUCTIONS

606-36. Programming commands and instrument responses are explained in Table 606-5.

606-37. LIST OF REPLACEABLE PARTS

606-38. Table 606-6 is a list of replaceable parts for the Bit Serial Interface Option. Refer to Section 5 for an explanation fo the columnar entries.

Table 606-4. Bit Serial Interface Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *The instrument must be connected through a bus network to a system controller, e.g., the Tektronix 4051 or HP 9825, to operate.*		
1	This troubleshooting procedure is based on the assumption that the instrument has been checked in local and found to be operational in all aspects prior to installation of the Bit Serial Interface.		
2	Install the Bit Serial Interface in the instrument and apply power from the front panel switch.		
3	Is the display blank?	4	7
4	Check the address lines and address decoders.		
5	Check for a high ACK line. Repair as required and resume at step 2.		
6	If the display is incorrect (garbled or wrong), check the input ID lines and gates. Repair as required and resume at step 2.		
7	Using the controller, instruct the instrument to go to remote (program the character "J").		
8	Does the instrument go into remote?	10	9
9	Check the input gates (TP1), the UART (U9), the baud rate at TP3, the INT circuit, and the status output buffer.		
10	Program several instructions from the remote controller.		
11	Does the instrument respond correctly to the programmed instructions?	13	12
12	Check the UART (U9), the output gates (U4), and the data input gate (U7). Repair as required and resume at step 10.		
13	Troubleshooting of the Bit Serial Interface, as applicable at this level, is complete.		

Table 606-5. Programming Instructions

The programming instructions in this table pertain to the 8500 Series Digital Multimeters with the IEEE-488 Interface (Option -05), the Bit Serial Interface (Option -06) or the Parallel Interface (Option -07) installed. Features and instructions unique to the DMM model or to the Interface used will be identified in the following manner:

1. 8500A or 8502A: the symbol ◆ will denote an explanation applicable to one DMM model only. The software version incorporated in the DMM may also be mentioned for further identification. To verify the software version incorporated in your instrument, observe the display indication at power on or reset. For example, in the 8502A, "HI-2.0.2" will appear in the display for models with software version 2.0.2.

2. -05, -06, or -07 Interface Options: the symbol ● will be used with a feature or instruction unique to a particular Interface.

INITIALIZATION

When power is applied, or the Reset character (*) is transmitted, the instrument assumes a preset default condition. This condition is defined by the following remote codes:

	REMOTE CODE	COMMAND
	V	Volts DC
	R4	1000V range
◆	S5 (8500A)	2^5 Samples per Reading
◆	S7 (8502A)	2^7 Samples per Reading
	F0	Fast Filter, Timeout Disabled (Panel Indicator OFF)
	X0	External Reference/Scaling Disabled
	P0	Offset Feature Disabled
	U0	Limits-Peak Value Storage Disabled
	T0	Single Reading Line Synchronous
	B0	Single Character ASCII Format
	D0	Front Panel Display Active
	L0	Deactivate Local Lockout
	J0	Deactivate Line Feed Suppression
	M0	Enable Cal Memory Factors
◆	Q0 (8502A)	Disable External Trigger
◆	W (8502A)	No Delay
●	Y0 (-06 Option only)	Echo mode off (Bit Serial IF)

In addition, the following instrument states are assumed at power on or Reset:

	Remote/Local	Local
	Offset	Zeroed
	V dc Zero	Zeroed or *
	Ohms Zero	Zeroed or *
	Cal Memory Factors	*
	Peak Values	Cleared
	Limits Values	Zeroed
	Ext. Ref/Scaling Values	1
●	8/16 Bit Mode (-07 Option only)	8 Bit

*Retained if Cal Memory Option -04 installed

Table 606-5. Programming Instructions (cont)

PROGRAM SEQUENCE

When equipped with a remote interface option, the instrument is programmed through a sequence of commands ("command string") that will determine range, function, reading rate, etc. Examples of 5 possible command strings are:

1. V A R 2 S 5 F ?
   - ? — Execute, trigger and transmit
   - F — Slow filter, no time out
   - S 5 — 2^5 samples/reading
   - R 2 — 10 volt range
   - V A — AC voltage

2. T D Y ?
   - ? — Execute, trigger and transmit
   - Y — Echo characters
   - D — Turn display off
   - T — Continuous line synchronized readings

3. K N U 6 . 3
   - K N U 6 . 3 — Upper limit

   K N L 6 . 2 U ,
   - , — Execute
   - U — Enter limits mode
   - K N L 6 . 2 — Lower limit

4. Z R , S 5 $
   - $ — Clears command string to preceeding "," "?" or "@"
   - S 5 — 2^5 samples/reading
   - , — Execute
   - R — Auto range
   - Z — Ohms

5. % G 1 ?
   - ? — Execute, trigger and transmit
   - G 1 — Get status and transmit on trigger
   - % — Halt reading

Table 606-5. Programming Instructions (cont)

All command string characters transmitted via the remote interface must be ASCII 7-bit upper case characters. A command string is a sequence of 1 to 31 characters. Characters are classified as immediate, command or termination. The instrument may be placed in Remote mode by toggling the front panel REMOTE switch or by transmitting any character that the instrument will recognize from the remote controlling terminal.

- With the IEEE Interface installed, the REMOTE switch can only be used to select local mode if already in Remote.

REMOTE is the only front panel switch to remain active when in REMOTE mode; REMOTE may, however, be locked out by the local lockout command.

IMMEDIATE CHARACTERS

There are 5 immediate characters; each of these may be executed at any time and does not require a termination character.

*** Reset**

This immediate character will reset the instrument to the conditions described under INITIALIZATION.

- ◆ When transmitted, the reset character must not be followed by any other character for 3 seconds with the 8502A (2 seconds with the 8500A). Any carriage return or line feed following the reset character must be suppressed. The remote interface will be unable to accept programming characters during this time.

% Halt

The halt character is used to terminate the continuous mode and cause the instrument to wait for a command string. No other characters should precede the halt character if continuous mode is in effect. Upon receipt of the halt character, the transmission of readings is terminated immediately. The following trigger mode transitions will occur when halt is used:

From: Continuous Line Synchronous
To: Single Reading Line Synchronous

From: Continuous Asynchronous
To: Single Reading Asynchronous

 # Go To Local - Lock Out Remote

- This character will command the instrument (Options -06 or -07 only) to enter local mode of operation and lock out the remote interface.
- The Remote mode may then be reentered by pressing the front panel REMOTE switch (for Option -06, -07). The Remote mode may not be reentered from the front panel when using the IEEE-488 Interface (Option -05).

Table 606-5. Programming Instructions (cont)

**Go To Local-Lock Out Remote (cont)**

The state of the instrument, when changing from remote to local operation will be modified as follows:

1. Ohms fast mode will be ignored.

◆ 2. Scaling mode will not be in effect (8500A only).

◆ 3. If the high averaged samples per reading rate was in effect, the samples per reading will be set to 2^7 (8500A only).

The state of the instrument when changing from local to remote operation will be modified as follows:

1. Ohms fast mode (Z1) and continuous reading mode will be resumed if the DMM was in either mode when place into local.

2. Any error that occurred during local operation will be stored and available for recall.

! **High Speed Reading Mode**

● The "!" character can be used with the Parallel Interface (Option -07) (and with the IEEE-488 Interface Option -05 in the 8502A only). The High Speed Reading mode provides a shortened 3-byte binary two's complement format response representing the input to the DMM's A/D Converter. Speeds up to 500 readings per second are possible in this mode of operation.

True readings can be computed from this response using range and function dependent factors (refer to Fluke Application Bulletin 25).

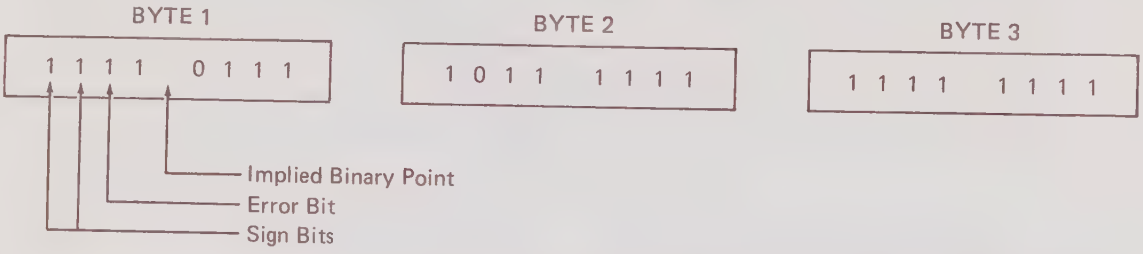
The High Speed Reading mode is suited to systems with very fast processors, to use with stored readings, or to applications not requiring direct numeric conversions (e.g., zero crossings or large deviations from a nominal value).

◆ Use of the "!" character will place the DMM in the High Speed Reading mode and trigger the first reading. Subsequent readings can be triggered by sending the "?" character. In addition, for the 8502A equipped with the -08A Option, subsequent readings can be triggered by sending the TTL pulse with the External Triggering Mode ("Q" or "Q1"). The High Speed Reading mode can be aborted at any time by transmitting a character other than "?" when a reading is to be triggered. The character sent in this case will do nothing more than cause the DMM to exit the High Speed Reading mode.

Table 606-5. Programming Instructions (cont)

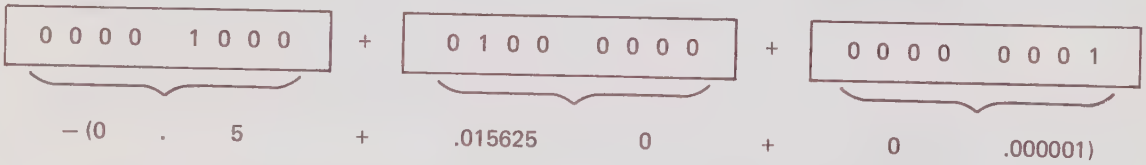
Voltage and Current Reading in "!"

The response data from the DMM will be in 3-byte format, as shown below, for each voltage or current reading. The first byte of this response contains sign and error bits, an implied binary point, and an implied scale factor of ten. Bytes 2 and 3 further define the reading. If the reading is negative, the sign bits will equal "1", and all three bytes must be two's complemented before conversion. If the error bit is equal to the complement of the sign bit, an error is defined.



In this example, the sign bits are "1" and the reading is negative. Since the complement of the sign bit does not equal the error bit ("1"), no error is defined.

To convert the response in this example, the two's complement must first be formed.



= 0.515626 X 10 (the implied scale factor)

Further conversion to calculate the true reading Rt necessitates multiplication of the A/D Converter reading (RAD) by the scale factor for the instrument's range and function.

$[R_t = R_{AD}$ X Scale Factor]

Ohms Readings in "!"

The procedure for measuring ohms in High Speed Reading mode is more complex. High Speed Ohms readings differ from Fast Ohms (Z1) readings; when using the "!" character, the DMM will not compute the true reading. This conversion must be performed by the user. Up to 500 readings a second are possible when using High Speed Ohms. Refer to OPERATING NOTES, provided with Option -05 and -07 for High Speed Ohms Reading procedures.

/ **8/16 Bit Toggle**

The "/" character is used to toggle between the 8-bit and the 16-bit mode. When this character is used to toggle from one mode to another, the immmediate and/or termination character must be placed in the least significant byte (LSB) of the programming word.

Table 606-5. Programming Instructions (cont)

TERMINATION CHARACTERS

Termination characters cause the execution of a command string. They are normally placed at the end of each programming statement.

$ Clear the Command String

● (Normally used only with the Bit-Serial Interface -06 Option.)

This character is used to erase an incorrect programming entry from the command string buffer, deleting all characters issued back to, but not including, the preceding termination character. A new command string is then needed to modify the state of the instrument.

, Execute the Command String

This character is used to cause the execution of the previous command string. The instrument will then be in the defined state only; the character will not trigger a reading or produce a response from the instrument. When programming a string of characters, it is recommended that the execute character be used at frequent intervals; if an error is made, the string need then be cleared only back to the last execute character. This execute character is also required if a command string longer than 31 characters is used.

? Execute the Command String and Trigger

This character will cause three actions: any previously entered command string will be executed, a reading will be taken, and that reading will be transmitted through the remote interface. If a command string was not entered immediately preceding this character, the instrument will take and transmit a reading in the last defined state.

An exception occurs when a command string containing a "Get" command has been entered; the instrument will then respond with the value or status that was requested by the command string (no reading will be triggered).

When issuing a program string terminated by the "?" character, the "CR" and/or "LF" delimiter characters should be, but do not have to be suppressed. If an error occurs during the reading, a single "0", followed by a "CR", will be transmitted. At this point, status should be requested to determine the cause of the error.

@ Execute, Trigger, and Interrupt when Ready

This character is used to trigger a reading and generate an interrupt when the reading is complete.

Table 606-5. Programming Instructions (cont)

@ Execute, Trigger, and Interrupt when Ready (cont)

- To provide the interrupt, the Bit-Serial Interface (Option -06) and the Parallel Interface (Option -07) transmit a single "CR". The IEEE-488 Interface (Option -05) provides an interrupt by generating a service request (SRQ).

The reading triggered by the "@" character can be obtained by inserting a "G" (get) command in the following command string (terminated by a "?").

The "@" character and the IEEE-488 Bus command "Group Execute Trigger" perform the same function.

COMMAND CHARACTERS

Command characters are classified within the following five groups:

1. FUNCTION
2. RANGE
3. MODIFIERS
4. CONTROL
5. MEMORY

FUNCTION COMMAND CHARACTERS

There are 7 function command characters. Whenever one of these characters is used, the state of the instrument will be changed as follows:

RANGE	Auto
MODIFIERS	Offset, Scaling, Limits, Peaks modes are turned off; stored values for these modes are retained.
MEMORY, CONTROL	Unchanged

If a function is selected requiring an optional module which is not loaded, the function of the instrument will be undefined, and the error code will be set to 19.

V DC Volts

V A AC Volts

C DC Coupled AC Volts

I DC Current

I A AC Current

Table 606-5. Programming Instructions (cont)

Z **Ohms**

Z **1** **Fast Ohms**

The Z1 character will place the instrument into the ohms function and the fast ohms mode. In normal ohms operation, the unknown resistor value Rx is computed from the following measurements:

V1-V2: the voltage across an internal precision resistor (Rr)

V0: the voltage across the unknown resistor (Rx).

The value of Rx is then computed with Ohm's Law:

$$Rx = Rr \frac{V0}{V1\text{-}V2}$$

Fast Ohms mode differs in that the value of $\frac{Rr}{(V1\text{-}V2)}$ is stored as a constant. The instrument will the find Rx by measuring V0 and multiplying this constant. The constant will change with a function change, range change or overload condition.

NOTE

Fast ohms ("Z1") differs from HIGH SPEED READING ("!"). When using "!" for ohms measurement, Rx is not computed by the DMM.

RANGE COMMAND CHARACTERS

The nine range commands specify the following maximum values by function.

	DC VOLTS	VA or C AC VOLTS	I or IA DC or AC CURRENT	Z or Z1 OHMS
R	Auto	Auto	Auto	Auto
R **0**	312 mV	Auto	312 μA	31.25Ω
R **1**	2.5V	2.5V	2.5 mA	250Ω
R **2**	20V	20V	20 mA	2 kΩ
R **3**	160V	160V	160 mA	32 kΩ
R **4**	1200V	1000V	1.28A	256 kΩ
R **5**	Auto	Auto	Auto	4.096 MΩ
R **6**	Auto	Auto	Auto	32.768 MΩ
R **7**	Auto	Auto	Auto	262.144 MΩ

Table 606-5. Programming Instructions (cont)

MODIFIER COMMAND CHARACTERS

SAMPLES PER READING COMMAND CHARACTERS

The modifier command character "S" or "H" specifies the number of samples taken per reading. The times shown for these characters are approximate digitizing times per reading for 60 Hz line synchronous operation in dc volts, ac volts or current function.

S 0	2^0 = 1 Sample/Reading (4 ms)
S 1	2^1 = 2 Samples/Reading (8 ms)
S 2	2^2 = 4 Samples/Reading (17 ms)
S 3	2^3 = 8 Samples/Reading (33 ms)
S 4	2^4 = 16 Samples/Reading (67 ms)
S 5	2^5 = 32 Samples/Reading (134 ms)
S 6	2^6 = 64 Samples/Reading (267 ms)
S 7	2^7 = 128 Samples/Reading (534 ms)
H 0	2^8 = 256 Samples/Reading (1.1s)
H 1	2^9 = 512 Samples/Reading (2.1s)
H 2	2^{10} = 1,024 Samples/Reading (4.3s)
H 3	2^{11} = 2,048 Samples/Reading (8.5s)
H 4	2^{12} = 4,096 Samples/Reading (17.1s)
H 5	2^{13} = 8,192 Samples/Reading (34.1s)
H 6	2^{14} = 16,384 Samples/Reading (68.3s)
H 7	2^{15} = 32,768 Samples/Reading (137s)
H 8	2^{16} = 65,536 Samples/Reading (273s)
H 9	2^{17} = 131,072 Samples/Reading (546s)

Table 606-5. Programming Instructions (cont)

FILTER COMMAND CHARACTERS

The "F" character is used to specify the type of filtering and the enabling of a time-out (for the filter settling time). This time-out causes a delay between a trigger command received and the actual reading taken. In the continuous trigger modes, the time-out will occur before each reading is initiated. The following "F" modifier command characters are used:

F	**Slow filter, time-out disabled.**
F 0	**Fast filter, time-out disabled.**
F 1	**Bypass filter.**
F 2	**Slow filter, time-out enabled (approximately 500 ms).**
F 3	**Fast filter, time-out enabled (approximately 50 ms).**

TRIGGER COMMAND CHARACTERS

The "T" characters specify the instrument's trigger mode. These characters determine whether samples taken are line synchronous (every 4 or 5 ms) or line asynchronous (approximately every 1.7 ms), whether single or continuous readings are to be taken.

T	**Continuous reading mode/line synchronized.**
T 0	**Single reading mode/line synchronized.**
T 1	**Continuous reading mode/line asynchronous.**
T 2	**Single reading mode/line asynchronous.**

NOTE

When line asynchronous modes are selected, the display will be turned off to save time; the front panel switches are then ignored.

◆ When in the continuous mode, any character (except "%" HALT) will be ignored by the instrument (8502A).

When in the Single Reading mode ("T0" or "T2"),and IEEE Group Execute Trigger command, a "?" or "@" character, or a TTL trigger (for the 8502A-08A) must be sent for each reading.

With the Continuous Reading mode ("T" or "T1"), use of the "GET" command, "?", "@" or a TTL trigger will start continuous readings.

Table 606-5. Programming Instructions (cont)

When each reading is accepted by the instrument controller, the next reading will be started. An exception to this sequence occurs in the "J1" Suppress Output mode; the next reading will now be taken immediately, without waiting for the output to the controller.

NOTE

The front panel display does not update in this mode unless the controller asks for a reading.

Use of the "%" character will halt the Continuous Reading mode and cycle the unit back to the Single Reading mode.

OFFSET COMMAND CHARACTERS

The "P" command characters specify whether an offset will be subtracted from a reading. The offset value may be entered by storing either a previous reading or a numerically entered offset.

- When storing readings, the 8500A will store the unprocessed reading, and the 8502A will store the displayed value.

Offset values may range from $\pm 1 \times 10^{9}$ to $\pm 1 \times 10^{-9}$ (including 0.0).

P **Offset subtracted (ON).**

P 0 **Offset not subtracted (OFF).**

EXTERNAL REFERENCE AND SCALING COMMAND CHARACTERS

The "X" command characters select External Reference or Scaling mode. Either mode is valid for any function and range. In External Reference mode, readings are divided by the signed magnitude of the external reference voltage. In Scaling mode, readings are divided by a numerically entered scale factor or by a previously read value.

X **External Reference On, Scaling Off**

The "X" External Reference mode uses the external reference voltage (Vxref) to divide the measured voltage. Vxref is measured during each reading cycle

- Minimum Vxref = ±0.0001V or the input divided by the maximum display with the volts range, whichever is greater (8500A only).
- For the 8502A, the minimum Vxref is the input divided by 10^{9}.

Maximum Vxref = ±40V between Ext Ref Hi and Lo terminals, providing neither terminal is greater than ±20V relative to the Sense Lo or Ohms Guard Terminals.

Table 606-5. Programming Instructions (cont)

X 0	**External Reference Off, Scaling Off**	
X 1	**External Reference Off, Scaling On**	The "X1" Scaling mode will divide all readings by a previously taken external reference voltage or by a previously entered numeric scale factor. The read valued may not be used as a scaling factor. ◆ Minimum scaling factor = the same as the minimum Vxref, for the 8500A. ◆ For the 8502A minimum = 10^{-9}. Factors less than this will be set to 0, which is not a valid scale factor. Maximum scaling factor = ±100 (8500A), or Input/Max Scale factor $<10^{-9}$ (8502A). *NOTE* *The "X" and "X1" modes are mutually exclusive.*

LIMITS AND PEAKS COMMAND CHARACTERS

The "U" command characters specify selection of Limits or Peaks modes.

U	**Limits Testing On**	When this command character is sent, each instrument reading is compared to upper and lower limits. Limit values must be entered separately with a keep command (refer to KEEP COMMAND CHARACTERS). The output format from the instrument (when given a "G" command) is as follows: "0" is transmitted for a reading within limits. "1" is transmitted for a reading greater than the upper limit. "–1" is transmitted for a reading less than the lower limit. "2" is transmitted if an error occurs (e.g., overranging).
U 0	**Disable Limits and Peak Mode(s)**	
U 1	**Save Highest and Lowest Values (Peaks On)**	Previous peak values are erased from memory whenever the "U1" command character is programmed.

Table 606-5. Programming Instructions (cont)

U 1	**Save Highest and Lowest Values (Peaks On) (cont)**	◆ For the 8500A, storage of limit and peak values are mutually exclusive. For the 8502A, limit and peak values can be held in memory simultaneously.

NOTE

Limits are applied after all other modifier operations (Scaling, Offset, etc.) have been performed.

CONTROL COMMAND CHARACTERS

Output Format

The "B" characters activate binary or ASCII output format.

B	**Single Byte Binary Format**	
B 0	**Single Byte ASCII Format**	
● B 1	**Binary 16-Bit Parallel**	"B1","B2" used with Paralled ASCII Interface (Option -07) only.
● B 2	**16-Bit Parallel**	

The front panel DMM display is turned on when the ASCII mode is entered and off when the binary mode is entered.

The Binary Output Format

The binary output format consists of five bytes. The first four bytes comprise a 32-bit binary two's complement fixed point number. An implied binary point for this number is located between the first and second bytes. The first 8-bit byte thus serves as the integer portion. The 24 bits of the next 3 bytes serve as the binary fraction. Additionally, since this format cannot be used to hold the entire range of possible values for the DMM, a fifth byte is used as an exponent. This exponent is a two's complement binary number representing the decimal exponent of the binary fixed point number defined by the first 4 bytes. An exception occurs in Limits testing; the response will then be single byte binary two's complement number.

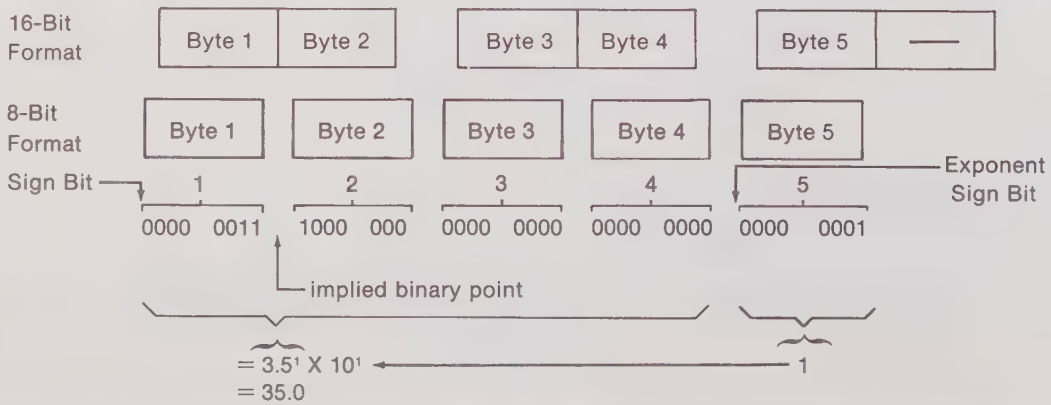


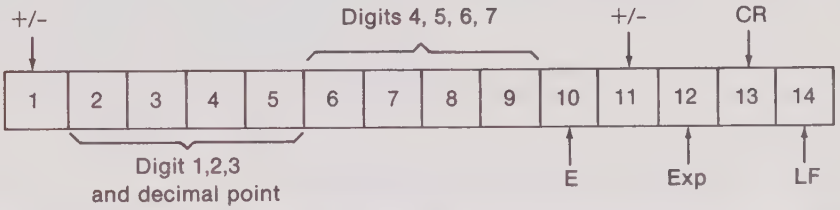
Table 606-5. Programming Instructions (cont)

NOTE

In dc volts and ac volts, the exponent is always 1. In dc and ac current, the exponent is always –2. The exponent is range dependent in ohms function (1 for ohm ranges, 4 for kohm ranges, and 7 for Mohm ranges).

Errors will be indicated by 5 bytes of 0.

ASCII Data Output Format



The seventh digit in the ASCII format corresponds to the "Cal" or HIRES digit of the front panel display. In some ranges and functions (e.g., 100 mV dc) this digit is permanently zeroed since it exceeds the resolution of the instrument. (When in the "Cal" or HIRES mode, the front panel will display the value of the reading rounded to six significant digits.)

DISPLAY CONTROL

The "D" command characters turn the DMM front panel display on or off.

D **Display Off**

D 0 **Display On**

When the "D0" command is used, the instrument will no longer interrogate any of the front panel switches (local lockout). The display will be turned On when the ASCII output format is commanded.

LOCAL LOCKOUT CONTROL

The "L" command characters select the local lockout condition, in which the display remains activated while none of the front panel switches affect the instrument.

L **Local Lockout On**

L 0 **Local Lockout Off**

ECHO COMMAND CHARACTERS

● **(used with Bit Serial Option -06 only)**

Y **ECHO ON (Full-Duplex)**

Y 0 **ECHO OFF (Half-Duplex)**

Table 606-5. Programming Instructions (cont)

LINE FEED CONTROL COMMAND CHARACTERS

J	**Suppress Line Feed Character**	This character suppresses the LF character normally sent at the end of a response line.
J 0	**Transmit Line Feed Character**	This character disables the "J" character; the "LF" character will be sent.
J 1	**Suppress Output of Readings**	◆ In the 8500A, use of J1 will suppress all output from the DMM. In the 8502A, use of J1 will suppress output with the following exceptions: Service Request (SRQ), status, recalled values. While in the J1 mode, use of the recall command "G ?" will retrieve a reading. Use of "J" or "J0" will exit the "J1" mode.

CALIBRATION CONSTANT

When the Calibration Memory (Option -04) module is installed, the "M" character will inhibit the adjustment of readings by the Calibration Memory correction factor. A slight increase in the speed of readings will result.

M	**Inhibit Calibration Memory Factors**
M 0	**Enable Calibration Memory Factors**

TRIGGER COMMAND CHARACTERS

◆ This set of command characters is available for the 8502A with the Isolator Option -08A.

Q	**Activate External Triggering Mode, Interrupt when Ready**	This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ).
Q 0	**Deactivate External Triggering Mode**	
Q 1	**Activate External Triggering Mode, Transmit when Ready**	The Q1 character also enables External Triggering mode. Any external TTL trigger initiates and transmits a reading.

NOTE

The "?" and "@" characters remain operative during External Triggering.

Table 606-5. Programming Instructions (cont)

◆ EXTERNAL TRIGGER DELAY COMMAND CHARACTERS
(-08A with 8502A only)

The "W" command characters select the amount of delay between the external trigger signal and the initiation of the reading.

W	No Delay
W 0	2.083 ms
W 1	4.166 ms
W 2	8.332 ms
W 3	16.66 ms
W 4	33.33 ms
W 5	66.66 ms
W 6	133.3 ms
W 7	266.6 ms
W 8	533.2 ms
W 9	1.066s
W 1 0	2.133s
W 1 1	4.266s
W 1 2	8.532s
W 1 3	17.06s
W 1 4	34.13s
W 1 5	68.26s

Table 606-5. Programming Instructions (cont)

MEMORY COMMAND CHARACTERS

STORE

The "K" (Keep) command characters specify the storing of a reading or numeric entry.

[K] **Store Last Reading as Offset**

◆ The 8500A will store the unprocessed reading, whereas the 8502A will store the displayed reading.

[K] [0] **Store Last Voltage Taken as VDC Zero (on R0 Only)**

[K] [1] **Store Last Reading as Ohms Zero (on R0 Only)**

[K] [N] [P] **Store Numeric Value Following as Offset**

[K] [N] [X] **Store Numeric Value Following as Scaling Factor**
(Note: The read value may not be stored as a Scaling Factor.)

[K] [N] [U] **Store Numeric Value Following as Upper Limit**

[K] [N] [L] **Store Numeric Value Following as Lower Limit**

Offsets, Scaling Factors, Upper and Lower Limits may be entered via the "KN" command characters, followed by one of the modifier characters "P", "X", "U" or "L" and the numeric value (on ASCII string of numeric characters, and optional sign, decimal point and signed decimal exponent digit in "E" notation).

Examples of legal numeric strings are:

[K] [N] [P] [1] [0]
Keep Numeric offset of 10.0

[K] [N] [X] [1] [0] [.] [3] [E] [-] [1]
Keep numeric scaling factor of 10.3×10^{-1} or 1.03

[K] [N] [U] [7] [.] [6] [E] [4]
Keep numeric upper limit of 7.6×10^{4}

[K] [N] [L] [-] [1] [2] [3] [.] [4] [5] [6] [E] [+] [0]
Keep numeric lower limit of −123.456

Table 606-5. Programming Instructions (cont)

An example of an illegal numeric string is:

K N X 2 . 0 E - 1 3

Exponent is limited to one signed integer digit, in this case the exponent would be -1 and the "3" would be ignored.

NOTE

Numeric entries are limited to the maximum display value. These values are:

+1.00000 E +9 to +1.00000 E -9, and -1.00000 E -9 to -1.00000 E +9

Numbers less the ±1.00000 E -9 are treated as zero.

RECALL

The "G" (Get) command characters specify the recall of a reading, a numeric entry or a status. Each "Get" command must be followed by a "?" termination character. The following memory "Get" commands may be used:

G **Recall Previous Reading and Send on Next Trigger**

G 0 **Recall DC Zero and Send on Next Trigger**

G 1 **Recall Status and Send on Next Trigger**

Status information from the DMM may be obtained with the command character "G1?". The status response will be returned in the following seven character format.

Error Codes

1	2					

Characters 1 and 2 define error code status. Each error code contains two digits: those codes with a zero for the first digit are related to remote operation only. All other codes contain the same second digit as the DMM's front panel error codes.

- 00 No Error
- 06 System Error
- 07 Illegal Numeric Entry
- 08 Remote Command String Error
- 09 Remote Overrange
- 10 V DC Zero/Ohms Zero Error
- ◆ 11 Offset Error (8500A) Store during Overrange (8502A)

Table 606-5. Programming Instructions (cont)

Error Codes (cont)

12 Filter Module Faulty or not installed
13 DC Signal Conditioner Module Faulty or not installed
14 Excessive voltage present at terminals for Ohms/Current Measurement
15 Fast A/D Converter Faulty or not installed
16 Numeric Display Overflow
17 Magnitude of External Reference Input >20V
18 Controller Module Faulty
19 Function Module selected not installed

Range Codes

		3				

The third character of the status response contains the following range information:

0 100 mV dc, 100 μA, 10Ω
1 1V dc, 1V ac, 1 mA, 100Ω
2 10V dc, 10V ac, 10 mA, 1kΩ
3 100V dc, 100V ac, 100 mA, 10 kΩ
4 1000V dc, 1000V ac, 1A, 100 kΩ
5 1 MΩ
6 10 MΩ
7 100 MΩ

Sample Codes

			4			

The fourth status response character contains sample information identified by the following codes:

0 1 Sample per Reading
1 2 Samples per Reading
2 4 Samples per Reading
3 8 Samples per Reading
4 16 Samples per Reading
5 32 Samples per Reading
6 64 Samples per Reading
7 128 Samples per Reading or Greater

Function Codes

				5	<CR>	<LF>

The fifth response character identifies function:

0 DC Volts
1 AC Volts
2 DC Amps
3 AC Amps
4 Ohms
5 DC Coupled AC Volts
7 Function Not Defined

Table 606-5. Programming Instructions (cont)

G N P	**Recall Offset and Send on Next Trigger**
◆ G N X	**Recall External Ref or Scaling Factor and Send on Next Trigger (8500A)** **Recall Scaling Factor (8502A)**
◆ G N R	**Recall External Reference Factor and Send on Next Trigger (8502A)**
G N U	**Recall Upper and Send on Next Trigger**
G N L	**Recall Lower Limit and Send on Next Trigger**

NOTE

The instrument will replay to "GNU" or "GNL" by transmitting the stored limit value.

G N Q	**Recall Lowest (Peak) Value Found and Send on Next Trigger**
G N W	**Recall Highest (Peak) Value Found and Send on Next Trigger**

Table 606-6. Bit Serial Asynchronous Interface Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Ⓐ BIT SERIAL ASYNCHRONOUS INTERFACE ASSY FIGURE 606-2 (MIS-4170)	ORDER	BY	OPTION MIS-06	1		
C1	CAP, TANT, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	3		
C2	CAP, TANT, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C3	CAP, TANT, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C4	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	2		
C5	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	REF		
C6	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	4		
C7	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C8	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C9	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
CR1	DIODE, HIGH-SPEED SWITCHING	203323	07910	1N4448	1	1	
H1	SCREW, PHP, 4-40 X 1/4	129890	73734	19022	2		
H2	SCREW, 6-32 X 1/4	320093	89536	320093	2		
H3	SPRING, COIL	424465	83553	C0120-014-0380	1		
H4	SPRING CLIP ASSY KIT	330134	02660	17-529	1		
H5	SCREW, 4-40 X 3/8	256164	89536	256164	1		
J1	CONNECTOR, D, SUB-MINI	413898	71785	DB25PV	1		
MP1	BAG, ANTI-STATIC (NOT SHOWN)	453548	89536	453548	1		
MP2	CASE HALF, MODULE	402990	89536	402990	1		
MP3	CASE HALF, MODULE, MODIFIED	412031	89536	412031	1		
MP4	COVER, MODULE CASE	402974	89536	402974	1		
MP5	DECAL	413492	89536	413492	1		
MP6	DECAL, CAUTION	454504	89536	454504	1		
MP7	GUARD, REAR	383364	89536	383364	1		
MP8	SHIELD, COVER	411983	89536	411983	1		
MP9	SHIELD, FRONT	383372	89536	383372	1		
Q1	XSTR, NPN, SI	218396	04713	2N3904	1	1	
Q2	XSTR, PNP, SI	226290	04713	MPS3640	1	1	
Q3	XSTR, PNP, SI	195974	04713	2N3906	1	1	
R1	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	2		
R2	RES, COMP, 47K +/-5%, 1/4W	148163	01121	CB4735	1		
R3	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	1		
R4	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	REF		
R5	RES, COMP, 10M +/-5%, 1/4W	194944	01121	CB1065	1		
R6	RES, COMP, 33K +/-5%, 1/4W	148155	01121	CB3335	1		
R7	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	2		
R8	RES, COMP, 2.2K +/-5%, 1/4W	148049	01121	CB2225	1		
R9	RES, COMP, 47 +/-5%, 1/4W	147892	01121	CB4705	1		
R10	RES, COMP, 750 +/-5%, 1/4W	218024	01121	CB7515	1		
R11	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	3		
R12	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
R13	RES, COMP, 620 +/-5%, 1/4W	221903	01121	CB6215	1		
R14	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	REF		
R15	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	REF		
S1	SWITCH, SPST, 8-POS.	414490	00779	435166-5	1		
U1	IC, TTL, DUAL EIA/MIL LINE RECEIVER	354704	18324	8T16A	1	1	
U2	Ⓐ IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE	1	1	
U3	Ⓐ IC, C-MOS, PRGMBLE BIT RATE GEN	418731	07263	F4702/34702	1	1	
U4	IC, TTL, MSI, DUAL EIA/MTL	354696	18324	N8T15A	1	1	

Table 606-6. Bit Serial Asynchronous Interface Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U5	Ⓐ IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	1	1	
U6	Ⓐ IC, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	2	1	
U7	Ⓐ IC, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	REF		
U8	Ⓐ IC, C-MOS, TRI, HEX, NON INV BUFFERS	407759	12040	MM80C97N	1	1	
U9	IC, UA, RECEIVER TRANSMITAL	354753	05828	AY-5-1013	1	1	
U10	Ⓐ IC, C-MOS, TRIPLE, 3-INPUT AND GATE	408807	02735	CD4073BE	1	1	
U11	Ⓐ IC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U12	Ⓐ IC, C-MOS, HEX, INV BUFFER	381830	02735	CD4050AE	1	1	
U13	Ⓐ IC, C-MOS, HEX, INV BUFFER	381830	02735	CD4050AE	REF		
V1	CRYSTAL, QUARTZ	435370	89536	435370	1		
XU9	SOCKET, IC, 40-PIN	418988	91506	340-AG39D	1		

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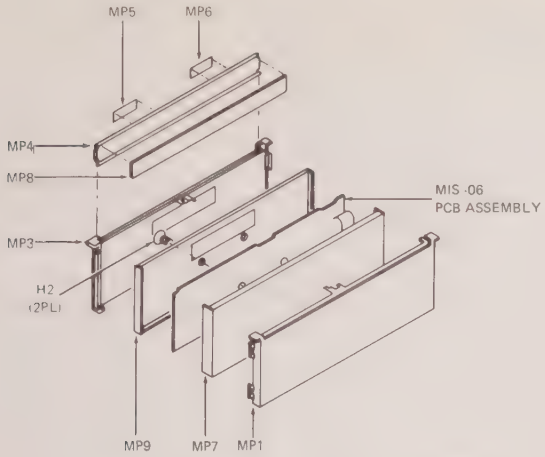


MODULE ASSEMBLY
-06 OPTION

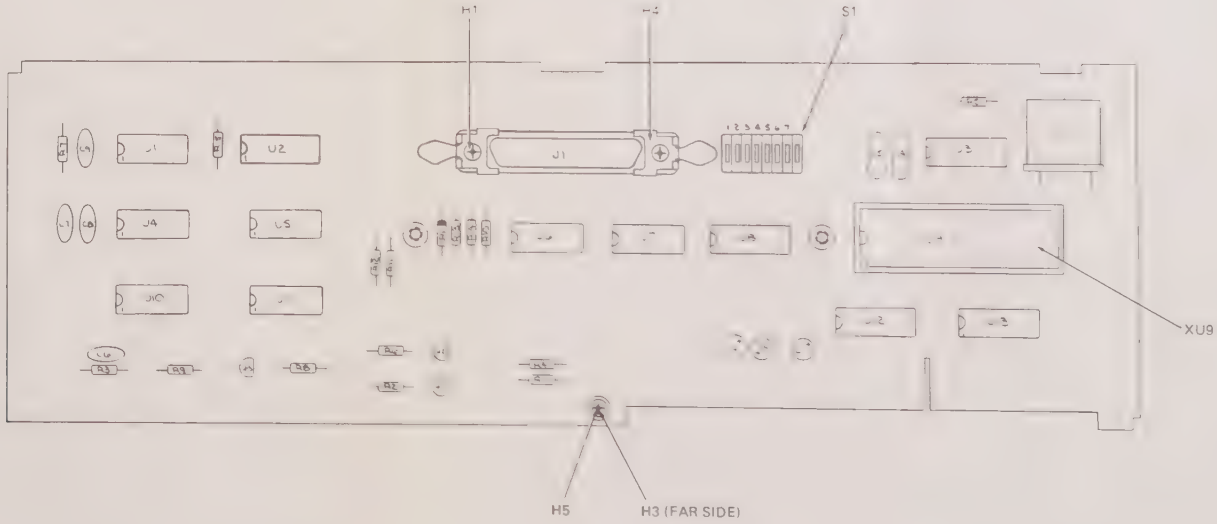


Figure 606-2. Bit Serial Asynchronous Interface Assembly

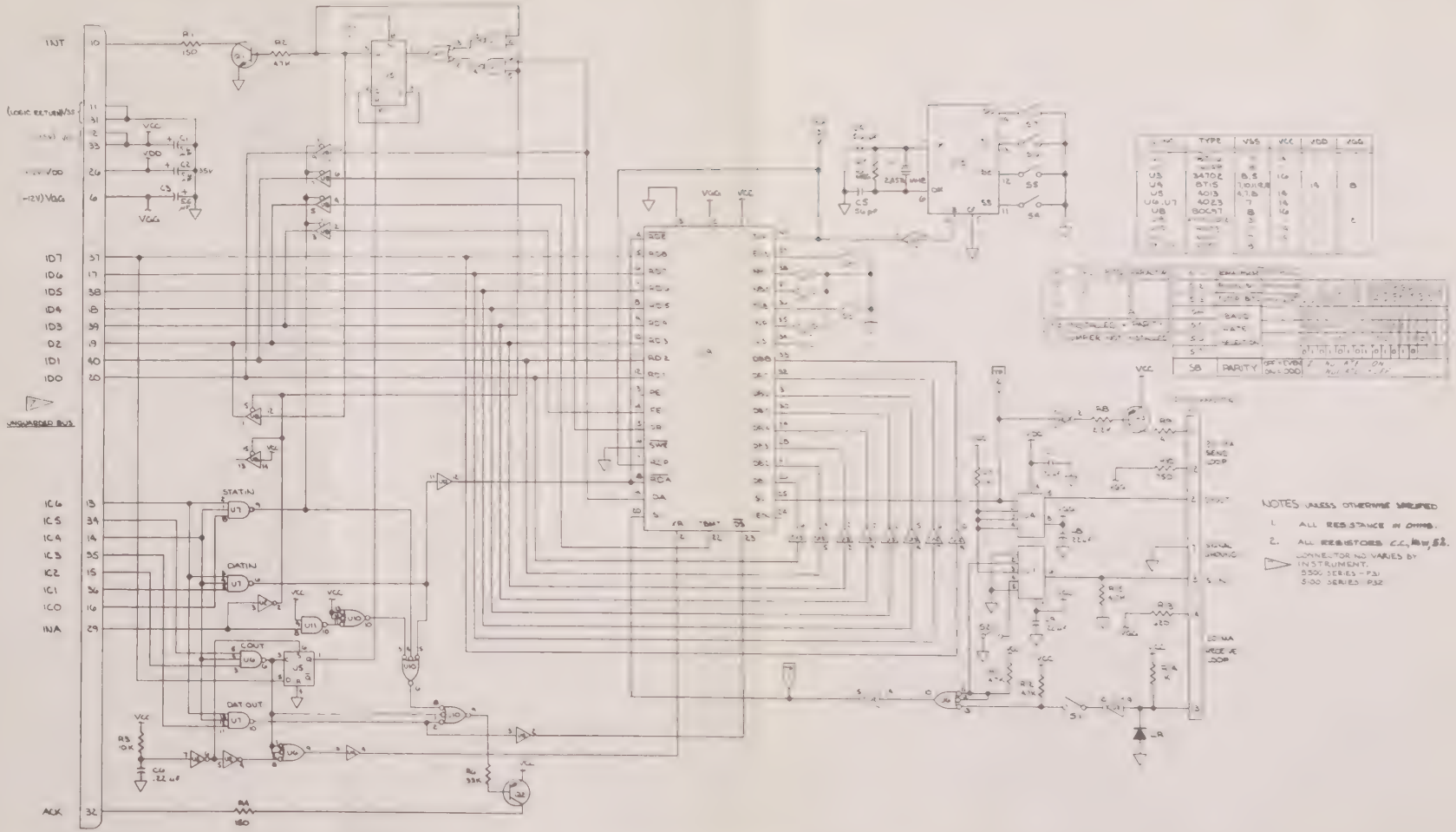


Figure 606-2. Bit Serial Asynchronous Interface Assembly (cont)

Option -07
Parallel Interface

607-1. INTRODUCTION

607-2. Installation of the Parallel Interface provides external programming capability in mini- and microcomputer systems. Program inputs must be in ASCII code. Outputs are remotely selectable between ASCII or binary (2's complement) and 8 or 16 bit characters.

607-3. Interfacing to a wide variety of devices is accomplished with a plug-in header termed a "personality card". By defining the pins, this card can be tailored to perform control of the DMM through the external device. Table 607-1 lists pins and definitions for the personality card. The personality card plugs into J2, as seen in Figure 607-1. Available personality cards are listed in Table 607-2.

607-4. Descriptions unique to the Parallel Interface will be provided separately from Programming Instructions in this manual. The Systems Multimeter Programming Card provided with the DMM lists condensed programming instructions. Fluke Application Bulletin #25 contains useful information concerning the use of the Parallel Interface.

Table 607-1. Personality Card Pin Definition

PIN NO.	INTERFACE MNEMONIC	BOARD - PIN DEFINITION
1	COS-B	= Control Output Strobe Buffered
2	$\overline{\text{COS-B}}$	= Control Output Strobe Inverted Buffered
3	COS	= Control Output Strobe
4	$OR2_A$	= OR Gate 2 Input A
5	$OR2_B$	= OR Gate 2 Input B
6	$OR2_A + OR2_B$	= OR Gate 2 Output
7	NC	= No Connection
8	COEN	= LSB Output Enable
9	DOEN	= MSB Output Enable
10	OSLE	= Output Strobe Latch Enable
11	ILAT	= Data Input MSB Latch
12	SLAT	= Control Input LSB Latch
13	ISLE	= Input Strobe Latch Enable
14	ILS	= Data Input Latch Strobe

Table 607-1. Personality Card Pin Definition (cont)

PIN NO.	INTERFACE MNEMONIC	BOARD-PIN DEFINITION
15	SLS	= Control Input Latch Strobe
16	DLR	= Data Output Latch Reset
17	CLR	= Control Output Latch Reset
18	QP	= High Output Delay Pulse
19	GND	= Ground
20	VCC	= +5V dc
21	$\overline{\text{INT}}$	= Interrupt Clock
22	$\overline{\text{CIS}}$	= Control Input Strobe Clock Inverted
23	$\overline{\text{QP}}$	= Low Output Delay Pulse
24	NC	= No Connection
25	$\overline{\text{IQ}}$	= Data Input Ready Low
26	IQ	= Data Input Ready High
27	$\overline{\text{DQ}}$	= Data Output Ready Low
28	DQ	= Data Output Ready High
29	TTL PU	= TTL Pull Up
30	OR1A	= OR Gate 1 Input A
31	OR1B	= OR Gate 1 Input B
32	OR1A + OR1B	= OR Gate 1 Output
33	$\overline{\text{CIS B}}$	= Control Input Strobe Inverted Buffered
34	CIS B	= Control Input Strobe Buffered
35	CIS	= Control Input Strobe
36	NC	= No Connection
37	HT	= High Trigger Delay Pulse
38	$\overline{\text{COR}}$	= Control Output Ready Inverted
39	LT	= Low Trigger Delay Pulse
40	$\overline{\text{CIR}}$	= Control Input Ready Inverted

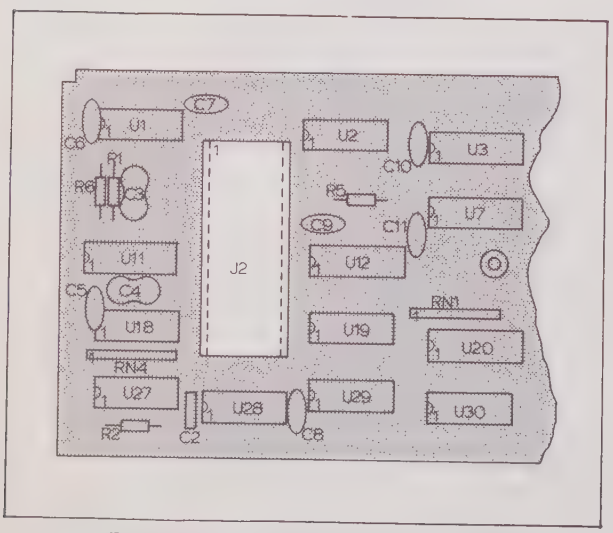


Figure 607-1. Personality Card Location

Table 607-2. Personality Cards

DESIGNATION	DESCRIPTION
-07A	Duplex Parallel Interface for PDP-11, DR11C, DRV-11.
-07B	Duplex Parallel Interface for PDP-11, PC11.
-07D	Duplex Parallel Interface (wiring completed by user).
-07H	Duplex Parallel Interface for HP12566B, 9825A.

607-5. INSTALLATION

607-6. The Parallel Interface is easily installed as a module in the 8500 series DMM. Use the following installation procedure:

1. On the DMM, press power OFF and remove the line power cord.

2. Remove the DMM's top cover.

3. Ensure that the desired personality card is installed on the Interface PCB. If necessary, refer to "Module Disassembly" in Section 4 of the Instruction Manual when accessing the Interface PCB.

4. Plug the personality card into J2 on the Parallel Interface PCB. The location of J2 is illustrated in Figure 607-1.

5. Reassemble the module (PCB and shield covers).

6. The Interface module fits in the rearmost slot, bus connector and address switches facing the rear. Slide the module vertically between the module guides, and press firmly into place.

NOTE

Make sure the leaf spring, attached to one-half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

7. Remove the Interconnect PCB, if installed, from slot K. This slot can be identified as the only one with connectors on the analog and digital bus lines. To remove the Interconnect PCB, grasp the board at both ends, and pull up. An end-to-end rocking motion may be necessary to free the PCB from its connectors. The Isolator module must be installed in slot K whenever a remote interface (Option -05, -06 or -07) is used in the DMM.

NOTE

Use Isolator -08 with the 8500A; Isolator -08A must be used with the 8502A.

8. Replace the DMM's top cover.

9. Energize the DMM.

607-7. OPERATING DIRECTIONS

607-8. The normal power-up condition of the Parallel Interface is eight-bit ASCII input and output. Command codes can change this to 16-bit ASCII input (two characters per transfer), 16-bit ASCII output, 8-bit Binary output, or 16-bit Binary output in character serial format.

607-9. When the front panel remote switch is pressed on the 8500A, the DMM stops measurements and waits for stimulation from the external device. On the 8502A, pressing the front panel remote switch results in the Parallel Interface trying to output data (ASCII 8-bit) in a continuous talk only mode.

607-10. THEORY OF OPERATION

607-11. Block Diagram Analysis

607-12. Data transfer through the Parallel Interface involves handshake processes between the interface and either the system controller or the instrument controller. Refer to the Block Diagram, Figure 607-2, during the following descriptions.

607-13. At power on, a reset circuit in the interface holds the control latches in the proper state until Vcc stabilizes. The instrument controller sends a software reset and an interrupt enable signal to the interface during its power on routine.

607-14. When ready to send data to the instrument, the system controller strobes the data into latches with a control signal. This signal is also used to interrupt the instrument controller. The controller then addresses the interface for the data. Upon termination of the address, a signal is generated to the system controller to indicate that the instrument is ready for more data.

607-15. Data outputs from the instrument are similarly handled. When a measurement is complete (last command string received), the instrument loads the data latches and signals the system controller that this data is ready. The system controller in turn responds with a data output strobe, enabling the data output buffers. The system controller in turn responds with a data output strobe, enabling the data output buffers. The controller also forms a status word, telling the instrument that more data may be outputted.

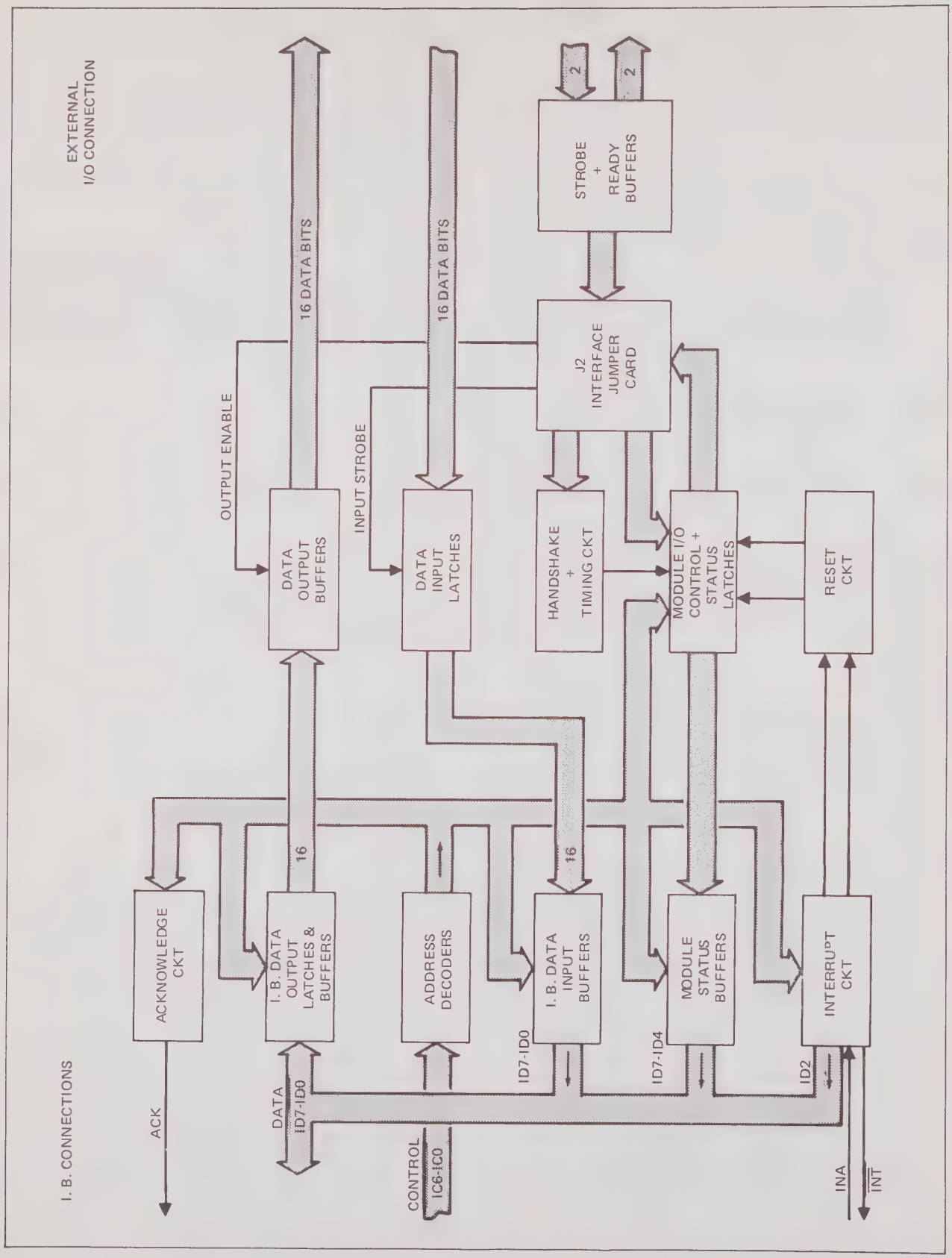


Figure 607-2. Parallel Interface Block Diagram

607-16. Circuit Analysis

607-17. The following circuit analysis is accurate for Parallel Interface with Personality Card DR11C (4068) installed; control signals COS, CIS, COR, and CIR are therefore positive true logic. Refer to the Schematic Diagram during the following circuit descriptions. Table 607-3 defines interface connections.

607-18. RESETS

607-19. Power up resets are controlled by the RC network connected to U19-13. The reset signal is applied through U1-11 and U8-4 to the control latches (U29-8 and U28-8 are reset, while U29-5 and U28-5 are set). Address IC5, 3, 2, decoded by U25-10, provides software resets.

607-20. ADDRESSES

607-21. For all addresses, an ACK response is returned to the instrument controller through U31-10 and Q1. Upon termination of the address, U30-12 is clocked. If ID7 is high, the interface is reset through U23-10, U23-11 and U19-12 and interrrupts are disabled. If ID7 is low at address IC5, 3, and 2, interrupts are enabled, U30-12 goes high. Since U30-2 was reset, U19-6 is high; U19-4 places a high on U30-5. When U30-2 is clocked, an interrupt will be generated from U20-11. When triggered by U19-10, U11-12 goes low to clear U29-5 and U28-5. The signal from U28-5, routed through the personality card to generate CIR, indicates to the system controller that the instrument is ready to receive data.

Table 607-3. Parallel Interface Connections

TITLE	MNEMONIC	J1 PIN NO.	SIGNAL FLOW
Input Strobe	CIS	31	From Control Device
Output Strobe	COS	37	From Control Device
MSD Bit 15 Input	I7	14	From Control Device
MSD Bit 14 Input	I6	15	From Control Device
MSD Bit 13 Input	I5	16	From Control Device
MSD Bit 12 Input	I4	17	From Control Device
MSD Bit 11 Input	I3	18	From Control Device
MSD Bit 10 Input	I2	19	From Control Device
MSD Bit 9 Input	I1	20	From Control Device
MSD Bit 8 Input	I0	21	From Control Device
LSD Bit 7 Input	S7	6	From Control Device
LSD Bit 6 Input	S6	7	From Control Device
LSD Bit 5 Input	S5	8	From Control Device
LSD Bit 4 Input	S4	9	From Control Device
LSD Bit 3 Input	S3	10	From Control Device
LSD Bit 2 Input	S2	11	From Control Device
LSD Bit 1 Input	S1	12	From Control Device
LSD Bit 0 Input	S0	13	From Control Device
Output Ready	COR	1	To Control Device
Input Ready	CIR	29	To Control Device
MSD Bit 15 Output	D7	46	To Control Device
MSD Bit 14 Output	D6	45	To Control Device
MSD Bit 13 Output	D5	44	To Control Device
MSD Bit 12 Output	D4	43	To Control Device
MSD Bit 11 Output	D3	42	To Control Device
MSD Bit 10 Output	D2	41	To Control Device
MSD Bit 9 Output	D1	40	To Control Device
MSD Bit 8 Output	D0	39	To Control Device
LSD Bit 7 Output	C7	22	To Control Device
LSD Bit 6 Output	C6	23	To Control Device
LSD Bit 5 Output	C5	24	To Control Device
LSD Bit 4 Output	C4	25	To Control Device
LSD Bit 3 Output	C3	50	To Control Device
LSD Bit 2 Output	C2	49	To Control Device
LSD Bit 1 Output	C1	48	To Control Device
LSD Bit 0 Output	C0	47	To Control Device

607-22. DATA INPUTS

607-23. The system controller strobes data into data latches U3, U7, U13 and U14 with the CIS line. The CIS-caused low on U2-2 is applied through the personality card to the clock inputs of U3, U7, U13 and U14 (clocks at termination of CIS), and to U11-1 (triggers U11-4 low). The low from U11-4 is routed through the personality card and U19-10 to clock U30-2. The output of U30-2 enables tri-state U20-11 to interrupt (INT) the instrument controller. When INA is returned, U8-2 goes low to enable tri-state U12-13 to place a high (from U30-1) on ID2 for use as the interrupt vector in the instrument controller. INA also causes an ACK response, INA is applied directly to U23-2 (U23-3 goes low and U19-10 goes low). Termination of INA clock, U30-1 low, ending the interrupt signal.

607-24. The interrupt vector tells the instrument controller to read data out of the interface. Address IC1, 4, 6 is decoded by U24-10 to enable tri-state buffers U12, U21 and U22. The low from U24-10 is applied through U27-4 to the clock input of U28-5. Termination of the address clocks U28-4 low. This state, transferred through the personality card and U2-6, causes CIR to go high and signals the system controller that the instrument is ready for more data. Reception of an execute command puts the instrument in the data output mode.

607-25. In the double character mode, data of the most significant byte (DATA IN) is read first and the least significant byte (CONTROL IN) is read second. In the data output mode the MSB is loaded first.

607-26. DATA OUTPUTS

607-27. Data bytes are loaded into data latches U15, U16, U17 and U26 by addresses IC0, 3, 5 (decoded by U25-9) and IC1, 3, 5 (decoded by U25-6). Termination of the addresses also clock U28-8 low. Applied through the personality card to U2-8, this low sets COR high. The system controller now sees that data is ready to be read from the interface.

607-28. The COS strobe is used by the system controller to enable tri-state buffers to drive the data on the system bus. A low from U2-12 enables U4, U5 and U6. A high on U2-10 is applied through the personality card to drive U18-3 and U18-6 low. Lows on the clock inputs of U29-8 and U28-8 are caused by U27-11 and U27-10, respectively. Termination of COS clocks the latches U29-8 and U28-8 high. This action terminates CIR and informs the system controller (through status latch U20-3, -5, -7, -9) that more data may be loaded out.

607-29. One complete reading in the 16-bit mode consists of seven transfers in ASCII (six with line feed suppression), or three transfers in binary code. Each reading in the eight bit mode consists of thirteen transfers in ASCII (twelve with line feed suppression) or five transfers in binary code. When a complete reading has been sent in either mode, the instrument controller resets the interface and enables interrupts. CIR goes high to indicate that the instrument is ready to receive data.

607-30. TROUBLESHOOTING

607-31. Troubleshooting the Parallel Interface requires an external control device with a parallel I/O, such as a PDP 11 with the DR11C Interface. When a problem is isolated to the Parallel Interface, it is recommended that the faulty unit be sent to the nearest service center for repair. Table 607-4, additionally provides a tabular flow chart approach to troubleshooting. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step in sequence.

607-32. PROGRAMMING INSTRUCTIONS

607-33. Programming command instructions are provided in Table 607-5.

607-34. PARTS LIST

607-35. Table 607-6 gives a parts breakdown for the Parallel Interface. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 607-4. Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	This troubleshooting procedure is based on the assumption that the instrument has been checked in local and found to be operational in all aspects prior to installation of the Parallel Interface.		
2	Install the Parallel Interface in the instrument and apply power from the front panel switch.		
3	Is the display blank?	4	6
4	Check for an address (IC) line held low. Check the address decoders.		
5	Check for the ACK line held high. Check the ACK circuitry. Repair as required and return to step 2.		
6	Is the wrong option configuration displayed at power on or reset?	7	8
7	Check for an address (IC) line held high. Check the address decoder. Repair as required and return to step 2.		
8	Is the display incorrect or garbled?	9	10
9	Check for an ID line held high or low. Check the input latch, output buffer, and INT set flip-flop.		
10	Instruct the instrument to go to remote by inputting a valid program character. Does the instrument go to remote?	12	11
11	Check the input strobe (CIS) J2-34; check for the INT circuit not being set (U30,19); check for the INT from the input strobe (J2-21).		
12	Select a mode from remote. Is the right mode selected?	14	13
13	Check the input data latches or buffers. Check the data strobe at J2-22, -12.		
14	Check the response data. Is there any, or is it correct?	16	15
15	Check the ready (COR) line. Check the output strobe (COS). Check the output latches or buffer.		
16	Is the response only a single byte of data?	17	18
17	Check the status flip-flops (U28, U29) for reset.		
18	Is the ready line hung?	18	19
19	Check for incorrect data out or bad input data.		
20	If there is no input, check for a bad input ready (CIR).		
21	Troubleshooting of the Parallel Interface as applicable at this level, is complete.		

Table 607-5. Programming Instructions

The programming instructions in this table pertain to the 8500 Series Digital Multimeters with the IEEE-488 Interface (Option -05), the Bit Serial Interface (Option -06) or the Parallel Interface (Option -07) installed. Features and instructions unique to the DMM model or to the Interface used will be identified in the following manner:

1. 8500A or 8502A: the symbol ◆ will denote an explanation applicable to one DMM model only. The software version incorporated in the DMM may also be mentioned for further identification. To verify the software version incorporated in your instrument, observe the display indication at power on or reset. For example, in the 8502A, "HI-2.0.2" will appear in the display for models with software version 2.0.2.

2. -05, -06, or -07 Interface Options: the symbol ● will be used with a feature or instruction unique to a particular Interface.

INITIALIZATION

When power is applied, or the Reset character (*) is transmitted, the instrument assumes a preset default condition. This condition is defined by the following remote codes:

	REMOTE CODE	COMMAND
	V	Volts DC
	R4	1000V range
◆	S5 (8500A)	2^5 Samples per Reading
◆	S7 (8502A)	2^7 Samples per Reading
	F0	Fast Filter, Timeout Disabled (Panel Indicator OFF)
	X0	External Reference/Scaling Disabled
	P0	Offset Feature Disabled
	U0	Limits-Peak Value Storage Disabled
	T0	Single Reading Line Synchronous
	B0	Single Character ASCII Format
	D0	Front Panel Display Active
	L0	Deactivate Local Lockout
	J0	Deactivate Line Feed Suppression
	M0	Enable Cal Memory Factors
◆	Q0 (8502A)	Disable External Trigger
◆	W (8502A)	No Delay
●	Y0 (-06 Option only)	Echo mode off (Bit Serial IF)

In addition, the following instrument states are assumed at power on or Reset:

Remote/Local	Local
Offset	Zeroed
V dc Zero	Zeroed or *
Ohms Zero	Zeroed or *
Cal Memory Factors	*
Peak Values	Cleared
Limits Values	Zeroed
Ext. Ref/Scaling Values	1
● 8/16 Bit Mode (-07 Option only)	8 Bit

*Retained if Cal Memory Option -04 installed

Table 607-5. Programming Instructions (cont)

PROGRAM SEQUENCE

When equipped with a remote interface option, the instrument is programmed through a sequence of commands ("command string") that will determine range, function, reading rate, etc. Examples of 5 possible command strings are:

1. V A R 2 S 5 F ?
   - Execute, trigger and transmit
   - Slow filter, no time out
   - 2^5 samples/reading
   - 10 volt range
   - AC voltage

2. T D Y ?
   - Execute, trigger and transmit
   - Echo characters
   - Turn display off
   - Continuous line synchronized readings

3. K N U 6 . 3
   - Upper limit

   K N L 6 . 2 U ,
   - Execute
   - Enter limits mode
   - Lower limit

4. Z R , S 5 $
   - Clears command string to preceeding "," "?" or "@"
   - 2^5 samples/reading
   - Execute
   - Auto range
   - Ohms

5. % G 1 ?
   - Execute, trigger and transmit
   - Get status and transmit on trigger
   - Halt reading

Table 607-5. Programming Instructions (cont)

All command string characters transmitted via the remote interface must be ASCII 7-bit upper case characters. A command string is a sequence of 1 to 31 characters. Characters are classified as immediate, command or termination. The instrument may be placed in Remote mode by toggling the front panel REMOTE switch or by transmitting any character that the instrument will recognize from the remote controlling terminal.

- With the IEEE Interface installed, the REMOTE switch can only be used to select local mode if already in Remote.

REMOTE is the only front panel switch to remain active when in REMOTE mode; REMOTE may, however, be locked out by the local lockout command.

IMMEDIATE CHARACTERS

There are 5 immediate characters; each of these may be executed at any time and does not require a termination character.

(*) Reset

This immediate character will reset the instrument to the conditions described under INITIALIZATION.

- ◆ When transmitted, the reset character must not be followed by any other character for 3 seconds with the 8502A (2 seconds with the 8500A). Any carriage return or line feed following the reset character must be suppressed. The remote interface will be unable to accept programming characters during this time.

(%) Halt

The halt character is used to terminate the continuous mode and cause the instrument to wait for a command string. No other characters should precede the halt character if continuous mode is in effect. Upon receipt of the halt character, the transmission of readings is terminated immediately. The following trigger mode transitions will occur when halt is used:

From: Continuous Line Synchronous
To: Signal Reading Line Synchronous

From: Continuous Asynchronous
To: Single Reading Asynchronous

(#) Go To Local - Lock Out Remote

- This character will command the instrument (Options -06 or -07 only) to enter local mode of operation and lock out the remote interface.
- The Remote mode may then be reentered by pressing the front panel REMOTE switch (for Option -06, -07). The Remote mode may not be reentered from the front panel when using the IEEE-488 Interface (Option -05).

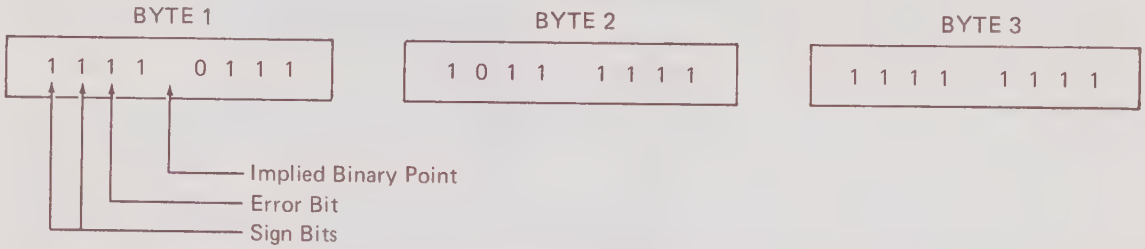
Table 607-5. Programming Instructions (cont)

#	**Go To Local-Lock Out Remote (cont)**	The state of the instrument, when changing from remote to local operation will be modified as follows: 1. Ohms fast mode will be ignored. ◆ 2. Scaling mode will not be in effect (8500A only). ◆ 3. If the high averaged samples per reading rate was in effect, the samples per reading will be set to 2^7 (8500A only). The state of the instrument when changing from local to remote operation will be modified as follows: 1. Ohms fast mode (Z1) and continuous reading mode will be resumed if the DMM was in either mode when place into local. 2. Any error that occurred during local operation will be stored and available for recall.
!	**High Speed Reading Mode**	● The "!" character can be used with the Parallel Interface (Option -07) (and with the IEEE-488 Interface Option -05 in the 8502A only). The High Speed Reading mode provides a shortened 3-byte binary two's complement format response representing the input to the DMM's A/D Converter. Speeds up to 500 readings per second are possible in this mode of operation. True readings can be computed from this response using range and function dependent factors (refer to Fluke Application Bulletin 25). The High Speed Reading mode is suited to systems with very fast processors, to use with stored readings, or to applications not requiring direct numeric conversions (e.g., zero crossings or large deviations from a nominal value). ◆ Use of the "!" character will place the DMM in the High Speed Reading mode and trigger the first reading. Subsequent readings can be triggered by sending the "?" character. In addition, for the 8502A equipped with the -08A Option, subsequent readings can be triggered by sending the TTL pulse with the External Triggering Mode ("Q" or "Q1"). The High Speed Reading mode can be aborted at any time by transmitting a character other than "?" when a reading is to be triggered. The character sent in this case will do nothing more than cause the DMM to exit the High Speed Reading mode.

Table 607-5. Programming Instructions (cont)

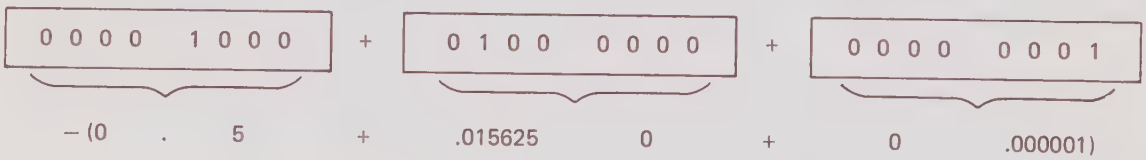
Voltage and Current Reading in "!"

The response data from the DMM will be in 3-byte format, as shown below, for each voltage or current reading. The first byte of this response contains sign and error bits, an implied binary point, and an implied scale factor of ten. Bytes 2 and 3 further define the reading. If the reading is negative, the sign bits will equal "1", and all three bytes must be two's complemented before conversion. If the error bit is equal to the complement of the sign bit, an error is defined.



In this example, the sign bits are "1" and the reading is negative. Since the complement of the sign bit does not equal the error bit ("1"), no error is defined.

To convert the response in this example, the two's complement must first be formed.



= 0.515626 X 10 (the implied scale factor)

Further conversion to calculate the true reading Rt necessitates multiplication of the A/D Converter reading (RAD) by the scale factor for the instrument's range and function.

$[R_t = R_{AD}$ X Scale Factor]

Ohms Readings in "!"

The procedure for measuring ohms in High Speed Reading mode is more complex. High Speed Ohms readings differ from Fast Ohms (Z1) readings; when using the "!" character, the DMM will not compute the true reading. This conversion must be performed by the user. Up to 500 readings a second are possible when using High Speed Ohms. Refer to OPERATING NOTES, provided with Option -05 and -07 for High Speed Ohms Reading procedures.

/ **8/16 Bit Toggle**

The "/" character is used to toggle between the 8-bit and the 16-bit mode. When this character is used to toggle from one mode to another, the immmediate and/or termination character must be placed in the least significant byte (LSB) of the programming word.

Table 607-5. Programming Instructions (cont)

TERMINATION CHARACTERS

Termination characters cause the execution of a command string. They are normally placed at the end of each programming statement.

$ Clear the Command String

● (Normally used only with the Bit-Serial Interface -06 Option.)

This character is used to erase an incorrect programming entry from the command string buffer, deleting all characters issued back to, but not including, the preceding termination character. A new command string is then needed to modify the state of the instrument.

, Execute the Command String

This character is used to cause the execution of the previous command string. The instrument will then be in the defined state only; the character will not trigger a reading or produce a response from the instrument. When programming a string of characters, it is recommended that the execute character be used at frequent intervals; if an error is made, the string need then be cleared only back to the last execute character. This execute character is also required if a command string longer than 31 characters is used.

? Execute the Command String and Trigger

This character will cause three actions: any previously entered command string will be executed, a reading will be taken, and that reading will be transmitted through the remote interface. If a command string was not entered immediately preceding this character, the instrument will take and transmit a reading in the last defined state.

An exception occurs when a command string containing a "Get" command has been entered; the instrument will then respond with the value or status that was requested by the command string (no reading will be triggered).

When issuing a program string terminated by the "?" character, the "CR" and/or "LF" delimiter characters should be, but do not have to be suppressed. If an error occurs during the reading, a single "0", followed by a "CR", will be transmitted. At this point, status should be requested to determine the cause of the error.

@ Execute, Trigger, and Interrupt when Ready

This character is used to trigger a reading and generate an interrupt when the reading is complete.

Table 607-5. Programming Instructions (cont)

@ **Execute, Trigger, and Interrupt when Ready (cont)**

- To provide the interrupt, the Bit-Serial Interface (Option -06) and the Parallel Interface (Option -07) transmit a single "CR". The IEEE-488 Interface (Option -05) provides an interrupt by generating a service request (SRQ).

The reading triggered by the "@" character can be obtained by inserting a "G" (get) command in the following command string (terminated by a "?").

The "@" character and the IEEE-488 Bus command "Group Execute Trigger" perform the same function.

COMMAND CHARACTERS

Command characters are classified within the following five groups:

1. FUNCTION
2. RANGE
3. MODIFIERS
4. CONTROL
5. MEMORY

FUNCTION COMMAND CHARACTERS

There are 7 function command characters. Whenever one of these characters is used, the state of the instrument will be changed as follows:

RANGE	Auto
MODIFIERS	Offset, Scaling, Limits, Peaks modes are turned off; stored values for these modes are retained.
MEMORY, CONTROL	Unchanged

If a function is selected requiring an optional module which is not loaded, the function of the instrument will be undefined, and the error code will be set to 19.

V **DC Volts**

V A **AC Volts**

C **DC Coupled AC Volts**

I **DC Current**

I A **AC Current**

Table 607-5. Programming Instructions (cont)

Z **Ohms**

Z **1** **Fast Ohms**

The Z1 character will place the instrument into the ohms function and the fast ohms mode. In normal ohms operation, the unknown resistor value Rx is computed from the following measurements:

V1-V2: the voltage across an internal precision resistor (Rr)

V0: the voltage across the unknown resistor (Rx).

The value of Rx is then computed with Ohm's Law:

$$Rx = Rr \frac{V0}{V1\text{-}V2}$$

Fast Ohms mode differs in that the value of $\frac{Rr}{(V1\text{-}V2)}$ is stored as a constant. The instrument will the find Rx by measuring V0 and multiplying this constant. The constant will change with a function change, range change or overload condition.

NOTE

Fast ohms ("Z1") differs from HIGH SPEED READING ("!"). When using "!" for ohms measurement, Rx is not computed by the DMM.

RANGE COMMAND CHARACTERS

The nine range commands specify the following maximum values by function.

	DC VOLTS	VA or C AC VOLTS	I or IA DC or AC CURRENT	Z or Z1 OHMS
R	Auto	Auto	Auto	Auto
R **0**	312 mV	Auto	312 μA	31.25Ω
R **1**	2.5V	2.5V	2.5 mA	250Ω
R **2**	20V	20V	20 mA	2 kΩ
R **3**	160V	160V	160 mA	32 kΩ
R **4**	1200V	1000V	1.28A	256 kΩ
R **5**	Auto	Auto	Auto	4.096 MΩ
R **6**	Auto	Auto	Auto	32.768 MΩ
R **7**	Auto	Auto	Auto	262.144 MΩ

Table 607-5. Programming Instructions (cont)

MODIFIER COMMAND CHARACTERS

SAMPLES PER READING COMMAND CHARACTERS

The modifier command character "S" or "H" specifies the number of samples taken per reading. The times shown for these characters are approximate digitizing times per reading for 60 Hz line synchronous operation in dc volts, ac volts or current function.

S 0	2^0 = 1 Sample/Reading (4 ms)
S 1	2^1 = 2 Samples/Reading (8 ms)
S 2	2^2 = 4 Samples/Reading (17 ms)
S 3	2^3 = 8 Samples/Reading (33 ms)
S 4	2^4 = 16 Samples/Reading (67 ms)
S 5	2^5 = 32 Samples/Reading (134 ms)
S 6	2^6 = 64 Samples/Reading (267 ms)
S 7	2^7 = 128 Samples/Reading (534 ms)
H 0	2^8 = 256 Samples/Reading (1.1s)
H 1	2^9 = 512 Samples/Reading (2.1s)
H 2	2^{10} = 1,024 Samples/Reading (4.3s)
H 3	2^{11} = 2,048 Samples/Reading (8.5s)
H 4	2^{12} = 4,096 Samples/Reading (17.1s)
H 5	2^{13} = 8,192 Samples/Reading (34.1s)
H 6	2^{14} = 16,384 Samples/Reading (68.3s)
H 7	2^{15} = 32,768 Samples/Reading (137s)
H 8	2^{16} = 65,536 Samples/Reading (273s)
H 9	2^{17} = 131,072 Samples/Reading (546s)

Table 607-5. Programming Instructions (cont)

FILTER COMMAND CHARACTERS

The "F" character is used to specify the type of filtering and the enabling of a time-out (for the filter settling time). This time-out causes a delay between a trigger command received and the actual reading taken. In the continuous trigger modes, the time-out will occur before each reading is initiated. The following "F" modifier command characters are used:

F	**Slow filter, time-out disabled.**
F 0	**Fast filter, time-out disabled.**
F 1	**Bypass filter.**
F 2	**Slow filter, time-out enabled (approximately 500 ms).**
F 3	**Fast filter, time-out enabled (approximately 50 ms).**

TRIGGER COMMAND CHARACTERS

The "T" characters specify the instrument's trigger mode. These characters determine whether samples taken are line synchronous (every 4 or 5 ms) or line asynchronous (approximately every 1.7 ms), whether single or continuous readings are to be taken.

T	**Continuous reading mode/line synchronized.**
T 0	**Single reading mode/line synchronized.**
T 1	**Continuous reading mode/line asynchronous.**
T 2	**Single reading mode/line asynchronous.**

NOTE

When line asynchronous modes are selected, the display will be turned off to save time; the front panel switches are then ignored.

◆ When in the continuous mode, any character (except "%" HALT) will be ignored by the instrument (8502A).

When in the Single Reading mode ("T0" or "T2"),and IEEE Group Execute Trigger command, a "?" or "@" character, or a TTL trigger (for the 8502A-08A) must be sent for each reading.

With the Continuous Reading mode ("T" or "T1"), use of the "GET" command, "?", "@" or a TTL trigger will start continuous readings.

Table 607-5. Programming Instructions (cont)

When each reading is accepted by the instrument controller, the next reading will be started. An exception to this sequence occurs in the "J1" Suppress Output mode; the next reading will now be taken immediately, without waiting for the output to the controller.

NOTE

The front panel display does not update in this mode unless the controller asks for a reading.

Use of the "%" character will halt the Continuous Reading mode and cycle the unit back to the Single Reading mode.

OFFSET COMMAND CHARACTERS

The "P" command characters specify whether an offset will be subtracted from a reading. The offset value may be entered by storing either a previous reading or a numerically entered offset.

- When storing readings, the 8500A will store the unprocessed reading, and the 8502A will store the displayed value.

Offset values may range from $\pm 1 \times 10^{9}$ to $\pm 1 \times 10^{-9}$ (including 0.0).

[P] **Offset subtracted (ON).**

[P] [0] **Offset not subtracted (OFF).**

EXTERNAL REFERENCE AND SCALING COMMAND CHARACTERS

The "X" command characters select External Reference or Scaling mode. Either mode is valid for any function and range. In External Reference mode, readings are divided by the signed magnitude of the external reference voltage. In Scaling mode, readings are divided by a numerically entered scale factor or by a previously read value.

[X] **External Reference On, Scaling Off**

The "X" External Reference mode uses the external reference voltage (Vxref) to divide the measured voltage. Vxref is measured during each reading cycle.

- Minimum Vxref = ±0.0001V or the input divided by the maximum display with the volts range, whichever is greater (8500A only).
- For the 8502A, the minimum Vxref is the input divided by 10^{9}.

Maximum Vxref = ±40V between Ext Ref Hi and Lo terminals, providing neither terminal is greater than ±20V relative to the Sense Lo or Ohms Guard Terminals.

Table 607-5. Programming Instructions (cont)

X 0	**External Reference Off, Scaling Off**	
X 1	**External Reference Off, Scaling On**	The "X1" Scaling mode will divide all readings by a previously taken external reference voltage or by a previously entered numeric scale factor. The read valued may not be used as a scaling factor. ◆ Minimum scaling factor = the same as the minimum Vxref, for the 8500A. ◆ For the 8502A minimum = 10^{-9}. Factors less than this will be set to 0, which is not a valid scale factor. Maximum scaling factor = ±100 (8500A), or Input/Max Scale factor $<10^{-9}$ (8502A). *NOTE* *The "X" and "X1" modes are mutually exclusive.*

LIMITS AND PEAKS COMMAND CHARACTERS

The "U" command characters specify selection of Limits or Peaks modes.

U	**Limits Testing On**	When this command character is sent, each instrument reading is compared to upper and lower limits. Limit values must be entered separately with a keep command (refer to KEEP COMMAND CHARACTERS). The output format from the instrument (when given a "G" command) is as follows: "0" is transmitted for a reading within limits. "1" is transmitted for a reading greater than the upper limit. "–1" is transmitted for a reading less than the lower limit. "2" is transmitted if an error occurs (e.g., overranging).
U 0	**Disable Limits and Peak Mode(s)**	
U 1	**Save Highest and Lowest Values (Peaks On)**	Previous peak values are erased from memory whenever the "U1" command character is programmed.

Table 607-5. Programming Instructions (cont)

U 1	**Save Highest and Lowest Values (Peaks On) (cont)**	◆ For the 8500A, storage of limit and peak values are mutually exclusive. For the 8502A, limit and peak values can be held in memory simultaneously.

NOTE

Limits are applied after all other modifier operations (Scaling, Offset, etc.) have been performed.

CONTROL COMMAND CHARACTERS

Output Format

The "B" characters activate binary or ASCII output format.

B	**Single Byte Binary Format**	
B 0	**Single Byte ASCII Format**	
● B 1	**Binary 16-Bit Parallel**	"B1","B2" used with Paralled ASCII Interface (Option -07) only.
● B 2	**16-Bit Parallel**	

The front panel DMM display is turned on when the ASCII mode is entered and off when the binary mode is entered.

The Binary Output Format

The binary output format consists of five bytes. The first four bytes comprise a 32-bit binary two's complement fixed point number. An implied binary point for this number is located between the first and second bytes. The first 8-bit byte thus serves as the integer portion. The 24 bits of the next 3 bytes serve as the binary fraction. Additionally, since this format cannot be used to hold the entire range of possible values for the DMM, a fifth byte is used as an exponent. This exponent is a two's complement binary number representing the decimal exponent of the binary fixed point number defined by the first 4 bytes. An exception occurs in Limits testing; the response will then be single byte binary two's complement number.

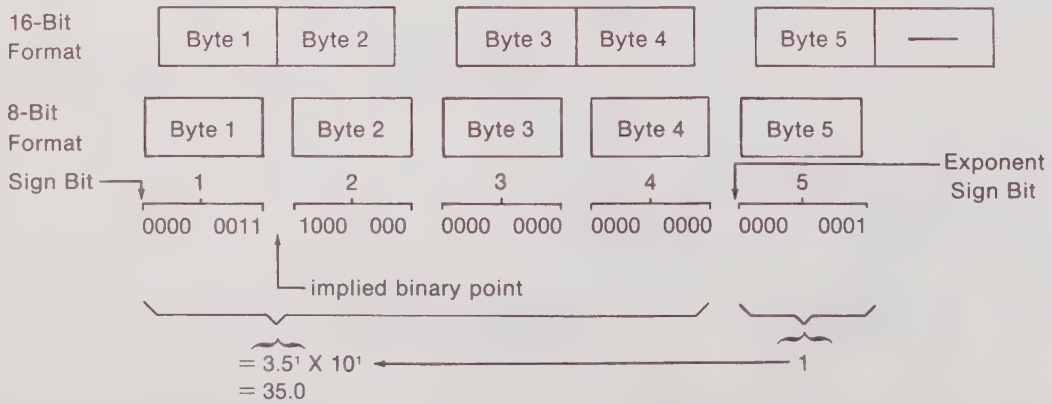


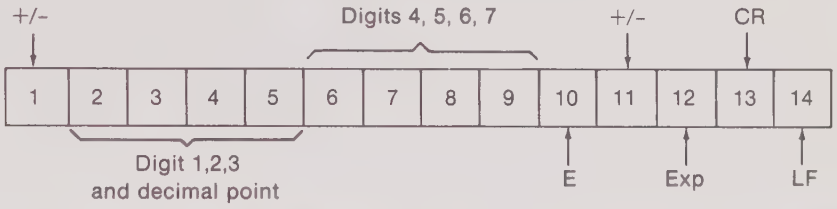
Table 607-5. Programming Instructions (cont)

NOTE

In dc volts and ac volts, the exponent is always 1. In dc and ac current, the exponent is always -2. The exponent is range dependent in ohms function (1 for ohm ranges, 4 for kohm ranges, and 7 for Mohm ranges).

Errors will be indicated by 5 bytes of 0.

ASCII Data Output Format



The seventh digit in the ASCII format corresponds to the "Cal" or HIRES digit of the front panel display. In some ranges and functions (e.g., 100 mV dc) this digit is permanently zeroed since it exceeds the resolution of the instrument). (When in the "Cal" or HIRES mode, the front panel will display the value of the reading rounded to six significant digits.)

DISPLAY CONTROL

The "D" command characters turn the DMM front panel display on or off.

D **Display Off**

D 0 **Display On**

When the "D0" command is used, the instrument will no longer interrogate any of the front panel switches (local lockout). The display will be turned On when the ASCII output format is commanded.

LOCAL LOCKOUT CONTROL

The "L" command characters select the local lockout condition, in which the display remains activated while none of the front panel switches affect the instrument.

L **Local Lockout On**

L 0 **Local Lockout Off**

ECHO COMMAND CHARACTERS
● (used with Bit Serial Option -06 only)

Y **ECHO ON (Full-Duplex)**

Y 0 **ECHO OFF (Half-Duplex)**

Table 607-5. Programming Instructions (cont)

LINE FEED CONTROL COMMAND CHARACTERS

J	**Suppress Line Feed Character**	This character suppresses the LF character normally sent at the end of a response line.
J 0	**Transmit Line Feed Character**	This character disables the "J" character; the "LF" character will be sent.
J 1	**Suppress Output of Readings**	◆ In the 8500A, use of J1 will suppress all output from the DMM. In the 8502A, use of J1 will suppress output with the following exceptions: Service Request (SRQ), status, recalled values. While in the J1 mode, use of the recall command "G ?" will retrieve a reading. Use of "J" or "J0" will exit the "J1" mode.

CALIBRATION CONSTANT

When the Calibration Memory (Option -04) module is installed, the "M" character will inhibit the adjustment of readings by the Calibration Memory correction factor. A slight increase in the speed of readings will result.

M	**Inhibit Calibration Memory Factors**
M 0	**Enable Calibration Memory Factors**

TRIGGER COMMAND CHARACTERS

◆ This set of command characters is available for the 8502A with the Isolator Option -08A.

Q	**Activate External Triggering Mode, Interrupt when Ready**	This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ).
Q 0	**Deactivate External Triggering Mode**	
Q 1	**Activate External Triggering Mode, Transmit when Ready**	The Q1 character also enables External Triggering mode. Any external TTL trigger initiates and transmits a reading.

NOTE

The "?" and "@" characters remain operative during External Triggering.

Table 607-5. Programming Instructions (cont)

◆ EXTERNAL TRIGGER DELAY COMMAND CHARACTERS (-08A with 8502A only)

The "W" command characters select the amount of delay between the external trigger signal and the initiation of the reading.

W	No Delay
W 0	2.083 ms
W 1	4.166 ms
W 2	8.332 ms
W 3	16.66 ms
W 4	33.33 ms
W 5	66.66 ms
W 6	133.3 ms
W 7	266.6 ms
W 8	533.2 ms
W 9	1.066s
W 1 0	2.133s
W 1 1	4.266s
W 1 2	8.532s
W 1 3	17.06s
W 1 4	34.13s
W 1 5	68.26s

Table 607-5. Programming Instructions (cont)

MEMORY COMMAND CHARACTERS

STORE

The "K" (Keep) command characters specify the storing of a reading or numeric entry.

K **Store Last Reading as Offset**

- The 8500A will store the unprocessed reading, whereas the 8502A will store the displayed reading.

K 0 **Store Last Voltage Taken as VDC Zero (on R0 Only)**

K 1 **Store Last Reading as Ohms Zero (on R0 Only)**

K N P **Store Numeric Value Following as Offset**

K N X **Store Numeric Value Following as Scaling Factor**
(Note: The read value may not be stored as a Scaling Factor.)

K N U **Store Numeric Value Following as Upper Limit**

K N L **Store Numeric Value Following as Lower Limit**

Offsets, Scaling Factors, Upper and Lower Limits may be entered via the "KN" command characters, followed by one of the modifier characters "P", "X", "U" or "L" and the numeric value (on ASCII string of numeric characters, and optional sign, decimal point and signed decimal exponent digit in "E" notation).

Examples of legal numeric strings are:

K N P 1 0
Keep Numeric offset of 10.0

K N X 1 0 . 3 E - 1
Keep numeric scaling factor of 10.3×10^{-1} or 1.03

K N U 7 . 6 E 4
Keep numeric upper limit of 7.6×10^{4}

K N L - 1 2 3 . 4 5 6 E + 0
Keep numeric lower limit of -123.456

Table 607-5. Programming Instructions (cont)

An example of an illegal numeric string is:

K N X 2 . 0 E - 1 3

Exponent is limited to one signed integer digit, in this case the exponent would be -1 and the "3" would be ignored.

NOTE

Numeric entries are limited to the maximum display value. These values are:

+1.00000 E +9 to +1.00000 E -9, and -1.00000 E -9 to -1.00000 E +9

Numbers less the ±1.00000 E -9 are treated as zero.

RECALL

The "G" (Get) command characters specify the recall of a reading, a numeric entry or a status. Each "Get" command must be followed by a "?" termination character. The following memory "Get" commands may be used:

G **Recall Previous Reading and Send on Next Trigger**

G 0 **Recall DC Zero and Send on Next Trigger**

G 1 **Recall Status and Send on Next Trigger**

Status information from the DMM may be obtained with the command character "G1?". The status response will be returned in the following seven character format.

Error Codes

1	2					

Characters 1 and 2 define error code status. Each error code contains two digits: those codes with a zero for the first digit are related to remote operation only. All other codes contain the same second digit as the DMM's front panel error codes.

- 00 No Error
- 06 System Error
- 07 Illegal Numeric Entry
- 08 Remote Command String Error
- 09 Remote Overrange
- 10 V DC Zero/Ohms Zero Error
- ◆ 11 Offset Error (8500A) Store during Overrange (8502A)

Table 607-5. Programming Instructions (cont)

Error Codes (cont)

12 Filter Module Faulty or not installed
13 DC Signal Conditioner Module Faulty or not installed
14 Excessive voltage present at terminals for Ohms/Current Measurement
15 Fast A/D Converter Faulty or not installed
16 Numeric Display Overflow
17 Magnitude of External Reference Input >20V
18 Controller Module Faulty
19 Function Module selected not installed

Range Codes

		3				

The third character of the status response contains the following range information:

0 100 mV dc, 100 μA, 10Ω
1 1V dc, 1V ac, 1 mA, 100Ω
2 10V dc, 10V ac, 10 mA, 1kΩ
3 100V dc, 100V ac, 100 mA, 10 kΩ
4 1000V dc, 1000V ac, 1A, 100 kΩ
5 1 MΩ
6 10 MΩ
7 100 MΩ

Sample Codes

			4			

The fourth status response character contains sample information identified by the following codes:

0 1 Sample per Reading
1 2 Samples per Reading
2 4 Samples per Reading
3 8 Samples per Reading
4 16 Samples per Reading
5 32 Samples per Reading
6 64 Samples per Reading
7 128 Samples per Reading or Greater

Function Codes

				5	<CR>	<LF>

The fifth response character identifies function:

0 DC Volts
1 AC Volts
2 DC Amps
3 AC Amps
4 Ohms
5 DC Coupled AC Volts
7 Function Not Defined

Table 607-5. Programming Instructions (cont)

G N P	Recall Offset and Send on Next Trigger
◆ G N X	Recall External Ref or Scaling Factor and Send on Next Trigger (8500A) Recall Scaling Factor (8502A)
◆ G N R	Recall External Reference Factor and Send on Next Trigger (8502A)
G N U	Recall Upper and Send on Next Trigger
G N L	Recall Lower Limit and Send on Next Trigger

NOTE

The instrument will replay to "GNU" or "GNL" by transmitting the stored limit value.

G N Q	Recall Lowest (Peak) Value Found and Send on Next Trigger
G N W	Recall Highest (Peak) Value Found and Send on Next Trigger

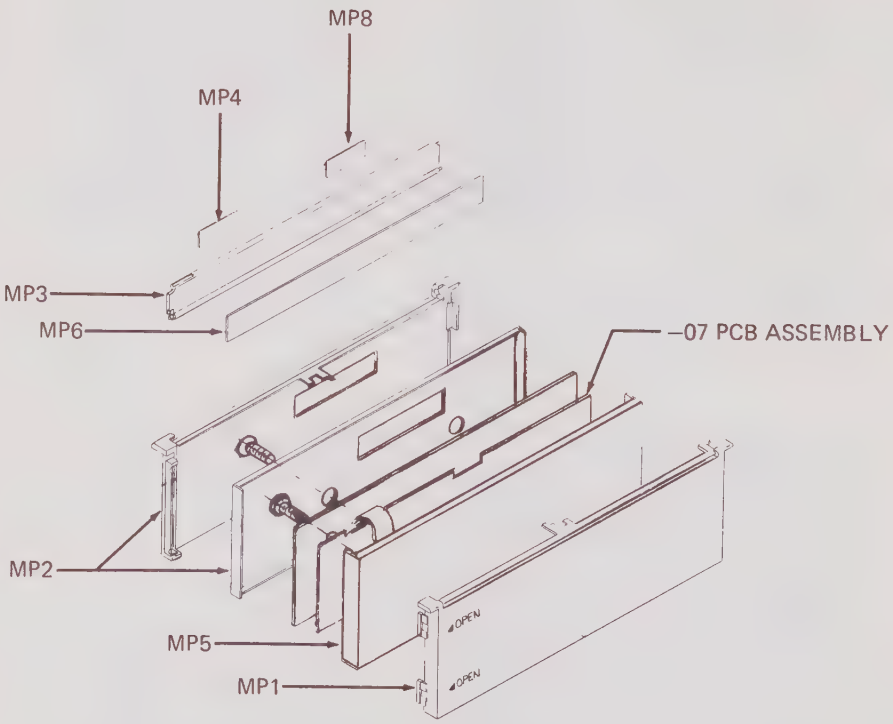
Table 607-6. Parallel Interface Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Ⓟ PARALLEL INTERFACE ASSEMBLY FIGURE 607-3 (MIS-4171)	ORDER	BY	OPTION MIS-07	1		
C5	CAP, CER, 560 PF +/-10%, 600V	106203	72982	801-00-X5R0-561K	1		
C6	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	7		
C7	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C8	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C9	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C10	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C11	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C12	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
H1	SPRING	412718	13511	57-1002-02	2		
H2	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
H3	SCREW, PHP, 4-40 X 1/4	129890	73734	19022	2		
H4	WASHER, INT/LK #4	110403	73734	99402	2		
H5	SPRING	424465	89536	424465	1		
J2	SOCKET, 12-PIN	425744	89536	425744	2		
J2-1	SOCKET, 4-PIN	417311	20447	SS-109-1-04	4		
MP1	CASE HALF	402990	89536	402990	1		
MP2	CASE HALF, MODULE	427625	89536	427625	1		
MP3	COVER, MODULE CASE	402974	89536	402974	1		
MP4	DECAL	413500	89536	413500	1		
MP5	GUARD, REAR	383364	89536	383364	1		
MP6	LATCH	412700	13511	57-1001	2		
MP7	SHIELD, COVER	411991	89536	411991	1		
MP8	DECAL, CAUTION	454504	89536	454504	1		
P1	CONNECTOR, CABLE, 50-PIN, MODIFIED	413138	13511	57-20500-31	1		
Q1	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	2		
R2	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	2		
R3	RES, COMP, 10K +/-5%, 1/4W	148106	01121	CB1035	REF		
R4	RES, COMP, 150 +/-5%, 1/4W	147934	01121	CB1515	1		
R5	RES, COMP, 1K +/-5%, 1/4W	148023	01121	CB1025	REF		
R6	RES, COMP, 2K +/-5%, 1/4W	202879	01121	CB2025	1		
RN1	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	4		
RN2	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	REF		
RN3	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	REF		
RN4	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	REF		
U1	IC, TTL, 2-INPUT POS OR GATE	393108	01295	SN74LS32N	1	1	
U2	IC, TTL, POS NAND GATES	292979	01295	SN7404N	1	1	
U3	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	4	1	
U4	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SN74367N	3	1	
U5	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SA74367N	REF		
U6	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SN74367N	REF		
U7	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U8	Ⓟ IC, C-MOS, HEX INVERTER/BUFFER	381848	02735	CD4049AE	1	1	
U9	Ⓟ IC, C-MOS, HEX INVERTER/BUFFER	381830	02735	CD4050AE	2	1	
U10	Ⓟ IC, C-MOS, HEX INVERTER/BUFFER	381830	02735	CD4050AE	REF		
U11	IC, LO-PWR SCHOTTKY	404186	01295	SN74LS123N	1	1	
U12	Ⓟ IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	4	1	
U13	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		

Table 607-6. Parallel Interface Assembly (cont)

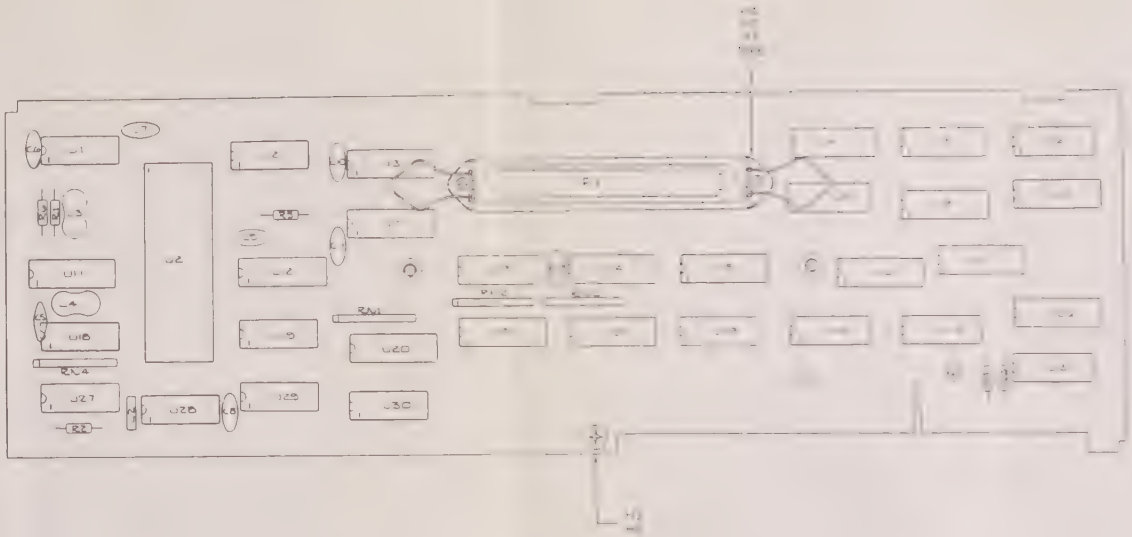
ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U14	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U15	IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	4	1	
U16	IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U17	IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U18	IC, TTL, QUAD, 2-INPUT POS NAND GATE	393033	01295	SN74LS00N	1	1	
U19	IC, C-MOS, QUAD, 2-INPUT, AND GATE	408401	02735	CD4081BE	2	1	
U20	IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U21	IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U22	IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U23	IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	1	1	
U24	IC, C-MOS, TRPL, 3-INPUT NAND GATE	375147	02735	CD4023AE	2	1	
U25	IC, C-MOS, TRPL, 3-INPUT NAND GATE	375147	02735	CD4023AE	REF		
U26	IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U27	IC, C-MOS, QUAD, 2-INPUT, AND GATE	408401	02735	CD4081BE	REF		
U28	IC, LO-PWR SCHOTTKY	393124	01295	SN74LS74N	2	1	
U29	IC, LO-PWR SCHOTTKY	393124	01295	SN74LS74N	REF		
U30	IC, C-MOS, DUAL TYPE "D" FLIP-FLOP	340117	02735	CD4013AE	1	1	
U31	IC, C-MOS, TRIPLE 3-INPUT, AND GATE	408807	02735	CD4073B	1	1	
U31.							
U31..							
	DR11C PERSONALITY CARD (MIS-4068) [1] FIGURE 605-3, DETAIL II	449439	89536	449439			
	PC11 PERSONALITY CARD (MIS-4069) [1] FIGURE 605-3, DETAIL II	449447	89536	449447			
	SFH PERSONALITY CARD (MIS-4070) [1] FIGURE 605-3, DETAIL II	449454	89536	449454			
	GP PERSONALITY CARD (MIS-4071) [1] FIGURE 605-3, DETAIL II	449462	89536	449462			
CR1	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	4	1	
CR2	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
MP1	CONNECTOR, POST	267500	00779	87022-1	40		
MP2							
MP3							
	HP PERSONALITY CARD PCB ASSEMBLY FIGURE 607-3, DETAIL III (MIS-4067T)	476218	89536	476218	1		
C1	CAP, CER, 0.01 UF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	1		
C2	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
R1	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	2		
R2	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	2		
R3	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R4	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R5	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
U1	IC, TTL, QUAD, 2-INPUT, POS AND GATES	393066	01295	SN74LS08	1	1	
U2	IC, TTL, LO-PWR SCHTKY MNSTB MULTVBRS	404186	01295	SN74LS123N	1	1	

[1] THE DR11C, PC11, SFH AND GP PERSONALITY CARDS HAVE THE SAME COMPONENT PARTS.



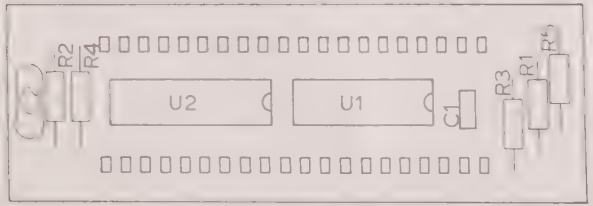
–07 MODULE ASSEMBLY (Detail I)

Figure 607-3. Parallel Interface Assembly



DETAIL II

CR3: SFH Personality Card
DR11C Personality Card
PC11 Personality Card
CR5: GP Personality Card



DETAIL III

Figure 607-3. Parallel Interface Assembly (cont)

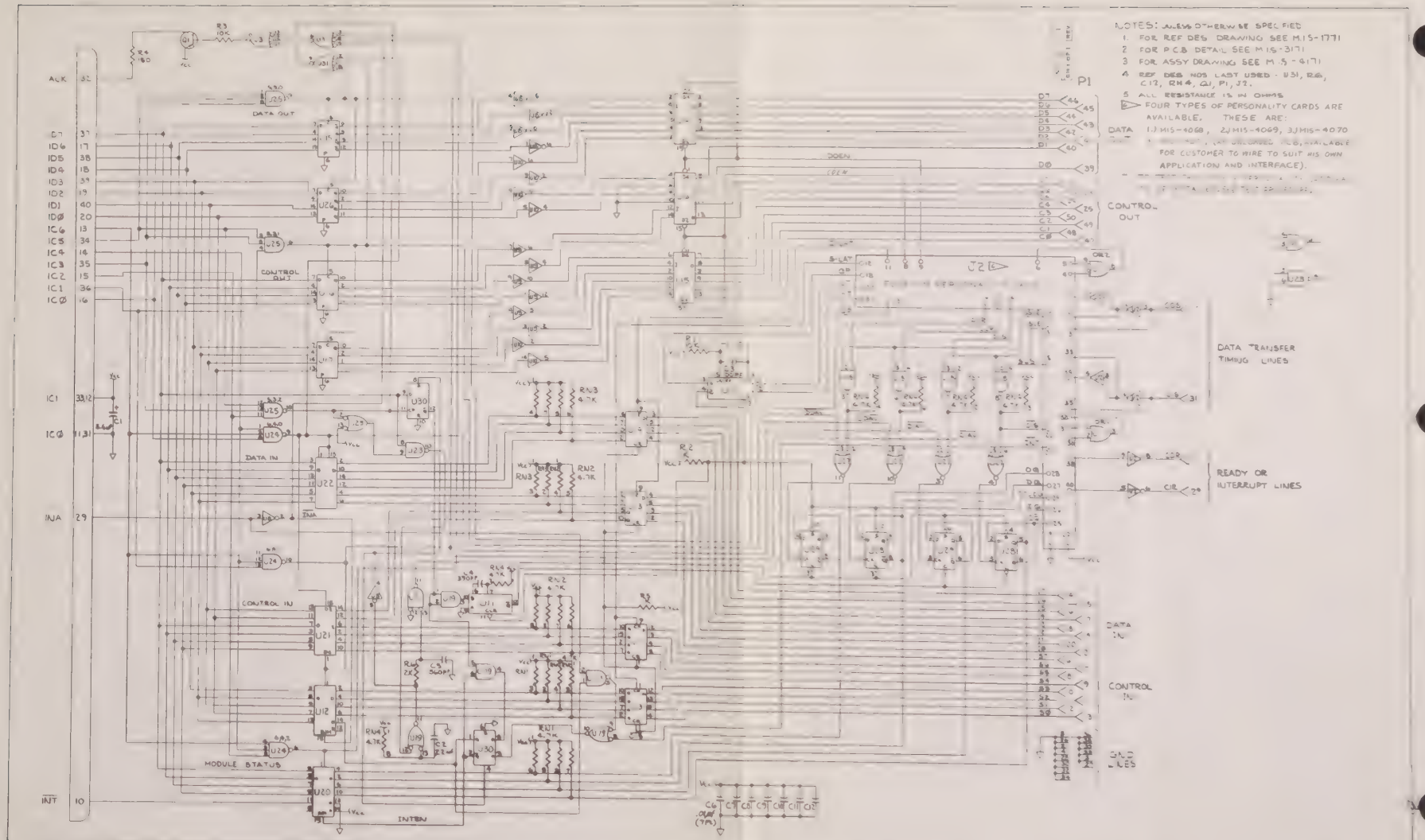
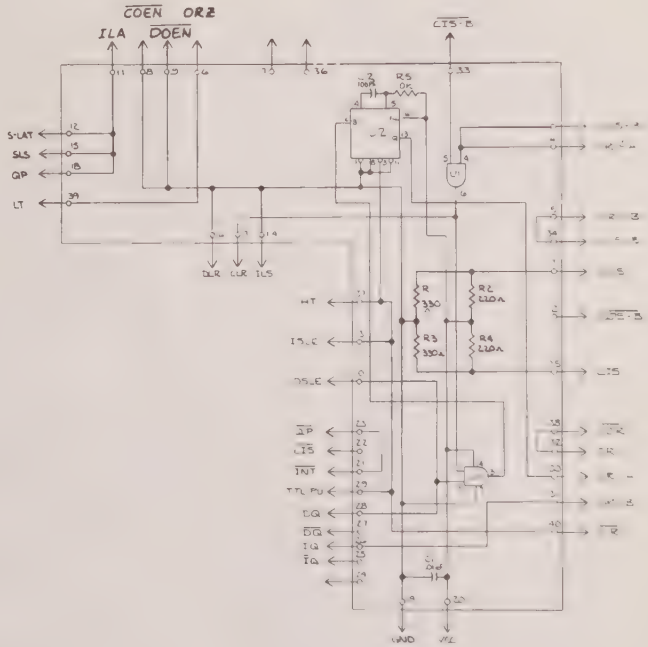
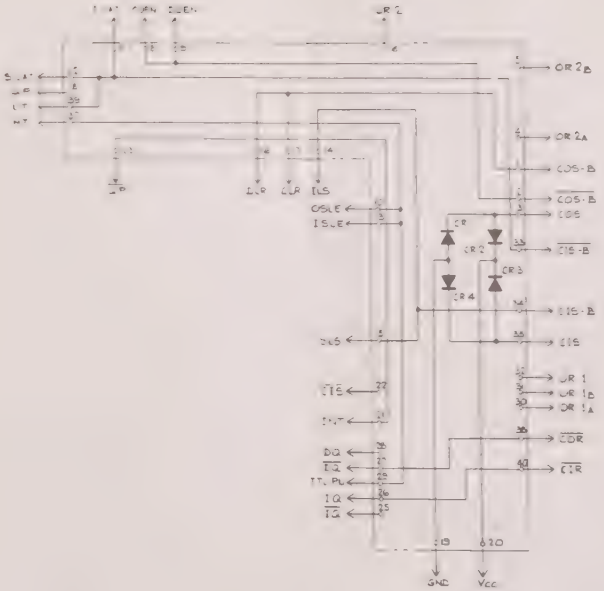


Figure 607-3. Parallel Interface Assembly (cont)

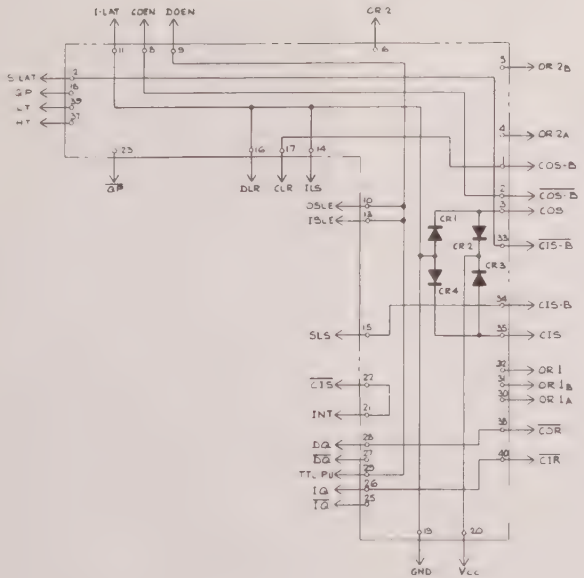


MIS-1067 (HP PERSONALITY CARD)

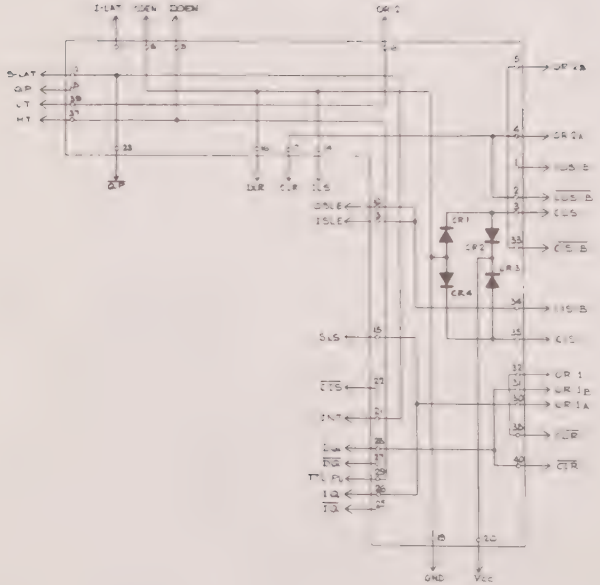


MIS-1068 (DR11C PERSONALITY CARD)

Figure 607-3. Parallel Interface Assembly (cont)



MIS-1069 (PC11 PERSONALITY CARD)



MIS-1070 (SFH PERSONALITY CARD)

Figure 607-3. Parallel Interface Assembly (cont)

Option —08
Isolator

608-1. INTRODUCTION

608-2. When an i/o interface (Options –05, –06, or –07) is installed, the Isolator must be installed to maintain the guarded nature of the analog bus. The module serially isolates the analog signal processing and conversion from the digital processing, control display, and input/output. The maximum allowable difference in potential between guard and logic common is 1000 volts.

608-3. INSTALLATION

608-4. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing a module. The isolator should replace the Interconnect pcb. The interconnect diagram in Section 8 contains a table showing the location of the slot.

608-5. OPERATING NOTES

608-6. Installation of the Isolator does not affect the operation of the instrument.

608-7. THEORY OF OPERATION

608-8. The Isolator accepts parallel data and address bytes, shifts them to serial format for transfer across isolation transformers, and converts them back to parallel format. Seven address lines are used for addressing analog modules with two lines (IC5 and 6) always low. Only one analog module sends data back to the controller: the A/D Converter uses ID7 to form its bit serial data stream. When the Isolator is installed V_{CC} and V_{SS} in the unguarded bus are isolated from analog common. Refer to the schematic, Figure 608-3, for the following discussion.

608-9. Two types of addresses may be sent from the controller to an analog module: a 3-of-7 address accompanied by data used to set up a module or a 2-of-7 indirect address sent to the A/D Converter to obtain a data bit. Address lines IC0-4 are applied through inverters to shift registers U3 and U7. Module set-up addresses must have one of IC0, 3, or 4 high, which places a low at one input of U10-6. U6-2 goes low, inhibiting U9-11 and enabling U10-8 to go high. All analog module addresses are formed with ones on IC0-4 so IC5 and 6 will be low. U12-11 and U12-3 go high enabling U10-12 to go low. The low going signal from U10-12 clocks a one-shot, U8-4. The consequent low from U8-4 loads data on ID0-7 and the address into U3 and U7. The low from U8-4 also disables a relaxation oscillator, U9-6 and U9-3, which runs at approximately 7.5 MHz. At the end of the load time determined by R2 and C2, U8-4 goes high which enables the oscillator.

608-10. Oscillator pulses from U11-4 and U11-10 clock data serially out of U7 and U3 (from U3-9), through U4 and the isolation transformers (T1, T2, T3, T4) and into U20 and U16. Note that one data input to U3-5 is V_{CC}, which ensures that data bit is high. As data is clocked serially into U20 and U16, U16-11 goes high when data loading is complete. This puts a high on U19-12, disabling the clock pulses from U24-4, and a high on U23-10, clocking U23-12 low, which enables the address gates, U22 and U26-4. Data from U20 and U16 is applied through buffers to the ID lines.

608-11. The low from U23-12 also enables U19-1 so that when the ACK is returned, U25-6 goes low and U19-1 goes high. U19-1 high enables a clock pulse from U24-4 and U24-12 to be applied through U15-3, U15-6, T8, and T7 to clock U8-10, resulting in an ACK signal from U8-12 through U5-6 and Q1.

608-12. In the case of indirect address, IC1, 2, U9-11 is no longer disabled. The above sequence of address and data transfer takes place. Of course there is no data to be sent to the A/D Converter; instead the controller is requesting data to be sent on ID7. Outputs from the address gates, U22 and U26-4, are decoded by U25-9 and U18-4 to cause a high at U18-3. This places U21-13 in the high impedance mode and enables U19-4 through U25-10. The data bit

returned on ID7 is applied through U26-3 and U19-4 to enable U15-8 and U15-11. A clock pulse from U24-4 and U24-12 through U15-11, U15-8, T6, and T5 clocks U14-5. This places a high at U13-10 (provided ID7 is high). U13-9 is enabled by U9-11 through U12-10 and U12-4. If ID7 is low, U19-4 does not go high.

608-13. During the load period (a low from U8-4), the clock (U9-3, U9-6) is disabled. Clock pulses from U24-4 are applied to a retriggerable monostable multivibrator, U23-13. When the clock pulses are disabled, U23-13 places a low on U20-9 and U16-9 to clear any previously latched data.

608-14. TROUBLESHOOTING

608-15. Figure 608-1 gives a symptom analysis approach to troubleshooting the Isolator module.

608-16. PARTS LIST

608-17. Table 608-1 gives a parts breakdown for the Isolator module. Refer to Section 5 of this manual for ordering information.

CAUTION ⊗

Indicated devices are subject to damage by static discharge.

Figure 608-1. Isolator Troubleshooting

SYMPTOM	POSSIBLE FAILURE
No Display at Power On	IC line held low U5, U12
Display Bad	IC line held high U5, U12 ID line held high or low U1, U2, U13
UNGUARDED SECTION	
Error 9 at Power On	Oscillator check U11 – 10 Shift Register U13 – 1, U7 Not transferring pulses U4, core windings ACK bad U9, U5, Q1, U6, U7
Option Configuration Wrong	Address lines hung
Can't Call Proper Ranges	Data lines hung U1, U2, U3
Constant Bad Reading Displayed	ID7 not returned U14, U13, core winding U12, U10, U9
GUARDED SECTION	
Error 9 or Configuration Wrong	U19 – 10, U16 – 1, U23 – 13 (Address, Data) U25, U19, U15, U24 (ACK) U24, U23 (Address)
Can't Call Proper Ranges	U16, U21, U18
Constant Bad Reading Displayed	U18, U26, U25, U19, U15 (ID7)

Table 608-1. MIS-4181 Isolator Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Ⓧ	**ISOLATOR ASSEMBLY** Figure: 608-2	383877	89536	383877	REF		
C1, C4	Cap, mica, 220 pF ±5%, 500V	170423	72136	DM15F220J	2		
C2	Cap, mica, 18 pF ±5%, 500V	266585	72136	DM15C180J	1		
C3	Cap, mica, 180 pF ±5%, 500V	148460	72136	DM15F181J	1		
C5	Cap, mica, 68 pF ±5%, 500V	148510	72136	DM15F680J	1		
C6	Cap, Ta, 39 uF ±20%, 6V	163915	56289	196D396X0006 KA1	1		
C7	Cap, elect, 150 uF −10/+50%, 16V	186296	73445	ET151X016A5	1	1	
C8, C9	Cap, mica, 27 pF ±5%, 500V	177998	72136	DM15E270J	2		
C10, C12, C13	Cap, cer, 0.22 uF ±20%, 50V	309849	71590	CW30C224K	3		
C11	Cap, cer, 4700 pF ±10%, 500V	106724	71590	CF472	1		
Q1	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
R1	Res, comp, 220 ±5%, 1/4W	147959	01121	CB2215	1		
R2, R5, R8 thru R13	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	8		
R3	Res, comp, 47k ±5%, 1/4W	148163	01121	CB4735	1		
R4, R7	Res, comp, 4.7k ±5%, 1/4W	148072	01121	CB4725	2		
R6	Res, comp, 1k ±5%, 1/4W	148032	01121	CB1025	1		
R14	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	1		
R15	Res, comp, 470 ±5%, 1/4W	147983	01121	CB4715	1		
T1, T3, T6, T8	Inductor	437608	89536	437608	4		
T2, T4, T5, T7	Inductor	437590	89536	437590	4		
U1, U2, U5	Ⓧ IC, Dgtl, C-MOS, hex, buffer/inverter	381830	02735	CD4050AE	3	1	
U3, U7	IC, TTL, MSI, 8-bit shift register	293118	01295	SN74165N	2	1	
U4, U15	IC, Dgtl, TTL, quad, 2-input, hi-vol, NAND	408021	01295	SN7426N	2	1	

Table 608-1. MIS-4181 Isolator Assembly (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U6, U24	⊗IC, Dgtl, TTL, hex inverter	393058	01295	SN74LS04N	2	1	
U8, U14, U23	⊗IC, Dgtl, TTL, lo-pwr	404186	01295	SN74LS123N	3	1	
U9	⊗IC, Dgtl, TTL, quad 2-input, NAND gate	363580	01295	SN74S00N	1	1	
U10	⊗IC, Dgtl, TTL, triple, input, POS NAND gates	393074	01295	SN74LS10N	1	1	
U11, U19	⊗IC, Dgtl, POS NOR gates, w/totempole output	393041	01295	SN74LS02N	2	1	
U12, U22, U26	⊗IC, Dgtl, COS/MOS, NOR gates	355172	02735	CD4001AE	3	1	
U13, U21	⊗IC, Dgtl, C-MOS, tri-state, hex, non-inverting buffers	407759	12040	MM80C97N	2	1	
U16, U20	IC, TTL, 8-bit serial-in parallel-out, shift register	272138	01295	SN74164N	2	1	
U17	Res Network, 10k, 16 pin	355305	89536	355305	1	1	
U18	⊗IC, Dgtl, C-MOS, quad, 2-input AND gate	408401	02735	CD4081BE	1	1	
U25	⊗IC, C-MOS, NOR gates	355180	02735	CD4025AE	1	1	
	Case half, module	402990	89536	402990	2		
	Cover, module case	402974	89536	402974	1		
	Decal Isolator	413534	89536	413534	1		
	Guard, front, left	437921	89536	437921	1		
	Guard, front, right	401513	89536	401513	1		
	Guard, rear, left	437947	89536	437947	1		
	Guard, rear, right	383349	89536	383349	1		
	Shield, cover	437939	89536	437939	2		

NOTES
1. FOR ASSY DRAWING SEE M.I.S - 4181
2. FOR PCB SEE M.I.S - 3181
3. FOR SCHEMATIC SEE M.I.S - 1181

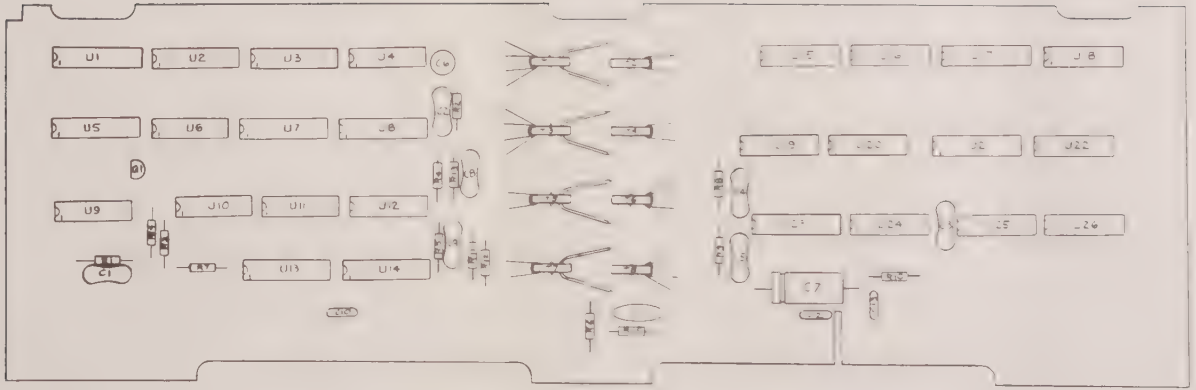


Figure 608-2. Isolator Assembly (M.I.S.-1781)

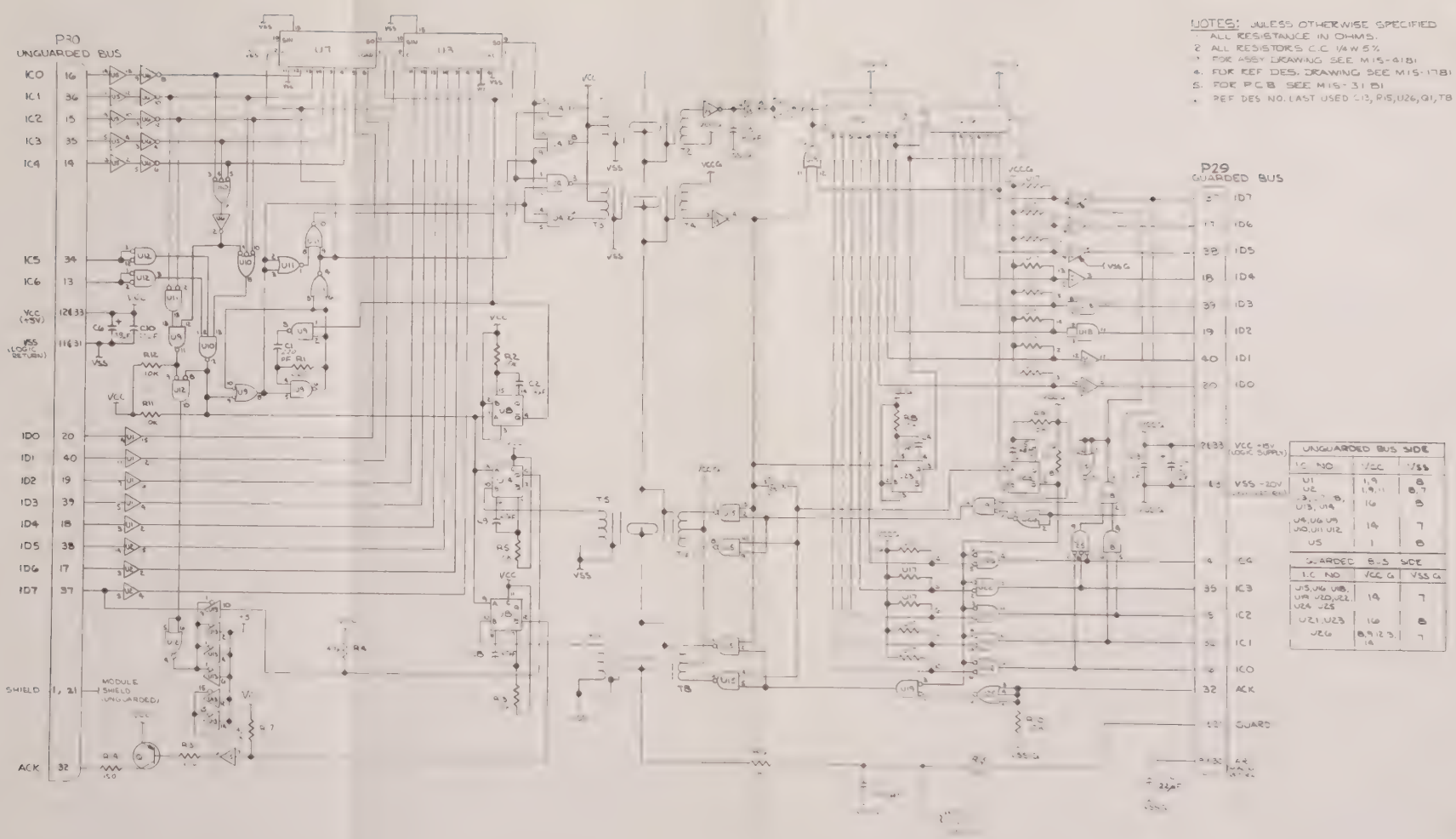


Figure 608-3. Isolator (M.I.S.-1181)

Option -08A
Isolator (External Trigger)

608A-1. INTRODUCTION

608A-2. The Isolator module maintains the guarded nature of the analog bus by isolating the analog signal processing and converting circuitry from the digital processing, control, display and input/output circuits. An isolator module (either Option -08 or -08A) must be installed whenever a remote interface (Option -05, -06, -07) is used in the 8500 series DMM. The following description pertains to the Isolator Option -08A only. Option -08A provides the capability for external triggering of the DMM. This mode may not be used in instruments which do not have mainframe and motherboard (A2) provisions for external triggering. Digital Multimeter Model 8502A will accept only the -08A Option; Model 8500A will accept the -08, or the -08A without external triggering capability.

608A-3. INSTALLATION

608A-4. Refer to Section 4 of the Instruction Manual for general module installation procedures. The Isolator module (Option -08A) replaces the Interconnect pcb in slot K; slot K can be identified as the only module slot with connectors on both the analog and digital bus lines. The Interconnect Diagram in Section 8 contains a table of slot locations.

608A-5. SPECIFICATIONS

608A-6. Input

608A-7. The trigger input is factory-wired for a high level of 4.3V (minimum) and a low level of 0.7V (maximum); pulse width should be greater than 10 μs. Common will be the same as interface logic common.

608A-8. The outer connector for external triggering is at interface common. There should be no more than 10V between the outer connector and earth ground.

608A-9. Trigger Processing Time

608A-10. The time between trigger edge and first A/D conversion (not including filter timeouts or programmed delays) is:

1. Non-line synchronous mode, .8 to .9 ms
2. Line synchronous mode, 1 to 6 ms
3. High speed mode (Option -05 or -07 installed), 114 $\pm$.5 μs

608A-11. OPERATING NOTES

608A-12. Installation of the Isolator (Option -08A) will not affect standard operation of the instrument. The External Triggering mode may, however, be activated locally from the front panel or through remote interfacing commands.

608A-13. Local Operation

608A-14. The External Triggering mode may be enabled from the DMM's front panel (Option -08A must be installed). To activate this mode, press TRIGGER. The SAMPLE LED will now stop flashing to denote that both External Triggering and Manual Triggering modes are in effect. Apply a negative going TTL level pulse to the external trigger input connector located on the rear panel. The SAMPLE LED will now flash once for each trigger received.

608A-15. The following considerations apply when External Triggering mode is in use:

1. A manual trigger attempted from the front panel will take precedence over an external trigger. If manual TRIGGER is pressed while a reading is in progress, the reading will be aborted and a new one started.

2. All other front panel switch applications will abort the reading in progress. A new reading

will not start until another trigger is received; the numeric display will not update until the new reading is complete.

608A-16. Remote Operation

608A-17. External Triggering can be enabled and controlled remotely when a remote interface (Option -05, -06, or -07) and the Isolator (Option -08A) are installed. The command characters in Table 608A-1 can be used from the remote.

608A-18. Trigger Polarity

608A-19. Either positive or negative going external triggers may be accepted by the Isolator (Option -08A); factory settings will be for negative triggers. Separate jumper wire arrangements are employed for negative and positive triggers. Refer to Figure 608A-1 for the location of jumper terminals on the Isolator PCB. To change the jumper arrangement, use the following procedure:

1. On the Digital Multimeter (8500 series), press POWER OFF and disconnect the line cord.

Table 608A-1. Remote Commands

	Ext. Trigger Commands
Q	Ext. Trigger—interrupt when ready
Q1	Ext. Trigger and Transmit Reading
Q0	Disable Ext. Trigger
	External Trigger Delay Commands
W	No Delay
W0	2.083 ms
W1	4.166 ms
W2	8.332 ms
W3	16.66 ms
W4	33.33 ms
W5	66.66 ms
W6	133.3 ms
W7	266.6 ms
W8	533.2 ms
W9	1,066s
W10	2.133s
W11	4.266s
W12	8.532s
W13	17.06s
W14	34.13s
W15	68.26s

2. Remove the Isolator module.

3. Observe Static Sensitive device precautions listed in Section 4 of the Instruction Manual. Avoid touching connector terminals on the Isolator PCB.

4. Remove the Guard Covers from the Isolator PCB using techniques outlined in Section 4 of the Instruction Manual (Module Assembly and Disassembly).

5. For negative going triggers, there will be a jumper between pin 1 and pin 4 on Schmitt Trigger U35.

6. For positive going triggers, remove the jumper between pins 1 and 4 and jumper pin 1 to 2 and 3 to 4 on U35.

7. Reassemble module, replace in Digital Multimeter.

608A-20. THEORY OF OPERATION

608A-21. The Isolator accepts parallel data and address bytes, shifts them to serial format for transfer across isolation transformers, and converts them back to parallel format. Seven address (ID) and eight data (ID) lines are used. Lines IC5 and IC6 are always low. The

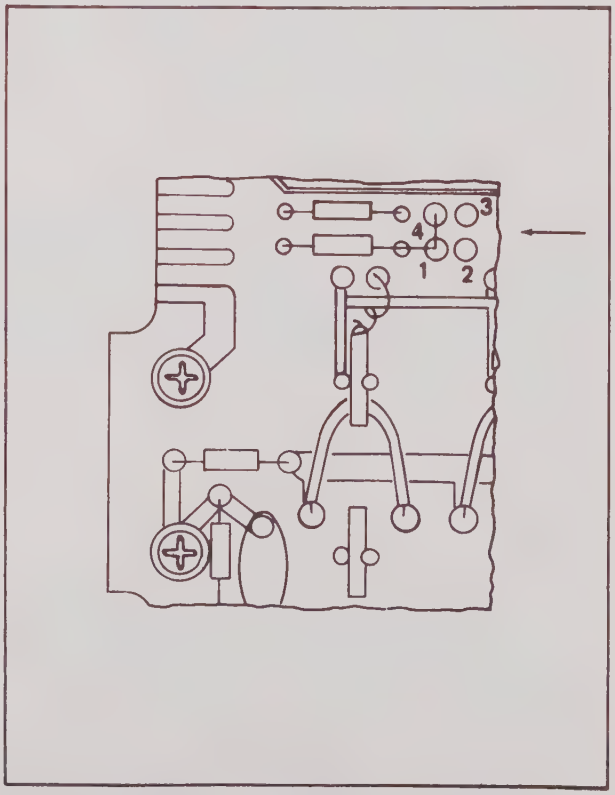


Figure 608A-1. Trigger Polarity Connections

Controller can send data to any addressed module; the A/D Converter will be the only analog module that sends data back to the Controller (bit serial data stream on ID7). Refer to the Isolator Schematic (Figure 608A-3) and the Functional Block Diagram (Figure 608A-2) for the following circuit descriptions.

NOTE

When the Isolator is Installed, Vcc and Vss in the unguarded digital bus are isolated from analog common.

608A-22. The description given in this paragraph will detail how data (ID0-ID7) and address (IC0-IC4) levels on the unguarded digital bus are loaded into shift registers (U3 and U7) in the Isolator. Inputs on address lines IC0-4 for either direct or indirect addresses are applied through inverters to shift register U7. Inputs on data lines (ID0-7) are applied to U7 (ID0, ID1) and U3 (ID2-7). A low on U14-12 will clock both address and data levels into the shift registers; the relaxation oscillator made up of U9-6 and U9-8 will be disabled by this same low during the load time. Monostable multivibrator U14-12 is clocked by a low going signal on U10-12. Two inputs to U10-12 will always be high (IC5, IC6 will always be low and are inverted). The third input will be a high from U10-8, which is enabled with any direct address on IC0-4 (IC0, 3, or 4 will have at least one high). The length of the load time will be determined by R2 and C2.

608A-23. At the end of the load time, relaxation oscillator U9-6 and U9-8 will be enabled, and data will be serially shifted out of registers U3 and U7, across isolation transformers T1 and T2, and into registers U20 and U6. Oscillator pulses from U11-10 and U11-13 clock serial data out of U3 and U7, and into U20 and U16. When this data transfer is complete, U16-11 will go high to enable address gates U22 and U26-4 and disable loading clock pulses to U20 and U16. Parallel data will then be applied through output buffers to ID0-7 on the guarded analog bus. Parallel address levels will be applied through the enabled address gates to address lines IC0-4 on the guarded analog bus.

608A-24. The clock pulse for U9-6 and U9-8 is disabled during the load period (U14-12 low). When clock pulses cease from U24-4, retriggerable monostable multivibrator U23-13 places a low on U20-9 and U16-9 to clear any previously latched data.

608A-25. An acknowledge (ACK) signal is transferred from the guarded analog bus to the unguarded digital bus by way of an isolation transformer. A low at U23-12 will enable U19-1 whenever an ACK is returned. With U19-1 high, a clock pulse from U24-4 and U24-12 is applied through U15-3, U15-6, T8 and T7. This pulse then clocks U8-2, resulting in an ACK signal out on U8-13.

608A-26. In order to obtain a data bit return on ID7, the indirect address is used in three ways. First, the address (IC1, IC2 high) is sent to the A/D Converter

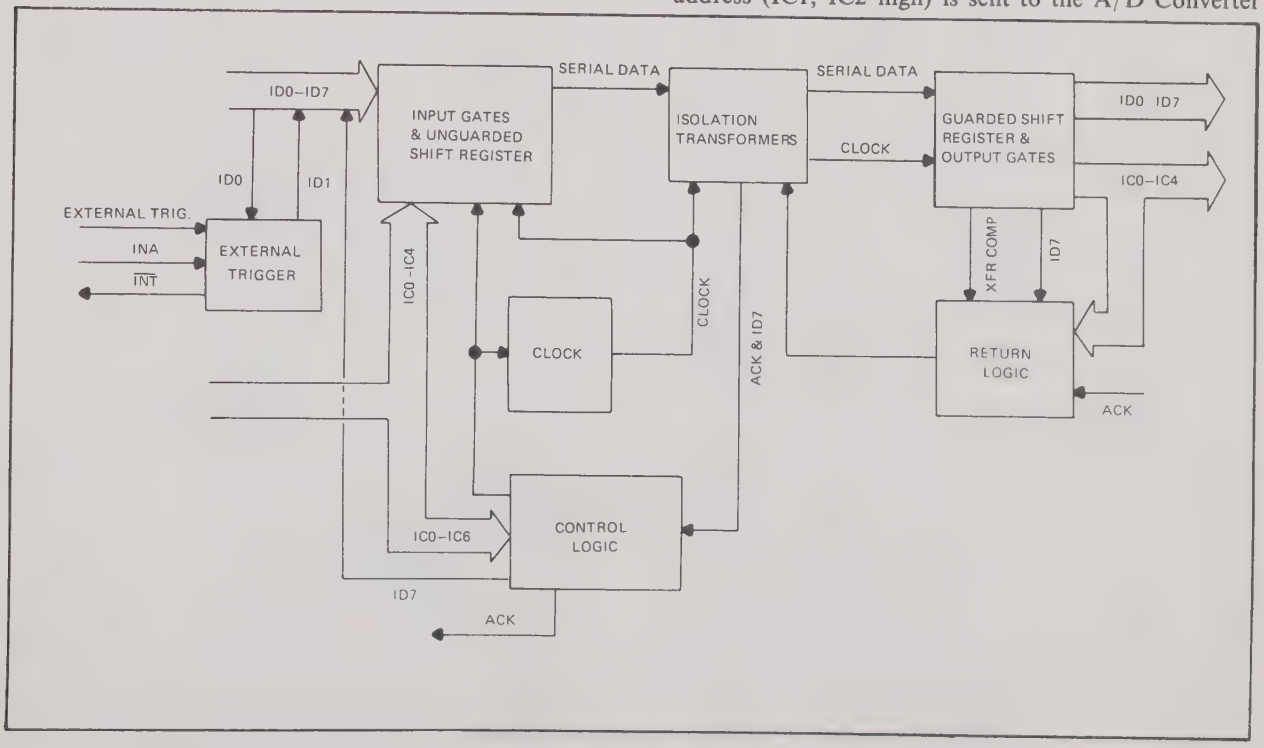


Figure 608A-2. Isolator Block Diagram

through the Isolator's shift register system. The address will also be used to enable U9-11 on the unguarded side of the Isolator. Thirdly, on the Isolator's guarded side, IC1 and IC2 high will enable address decoders U18-4 and U25-9. With U18-3 consequently high, tri-state device U21-13 is placed in the high impedance mode. A path is now enabled for ID7 levels from the guarded analog bus to be transferred back to the unguarded digital bus. For instance, with a high on U19-5, ID7 high will enable U19-4. Clock pulses from U24-4 and U19-4 high enable U15-11 and U15-8. While U9-11 enables U13-9, U8-5 clocked high places ID7 high on the unguarded digital bus.

608A-27. The following sequence of events takes place in the Isolator during external triggering. Dual D flip-flop U31 will be enabled by a low on ID0 and high at U33-9. Address lines IC4, IC5, and IC6 must all be high for U33-9 to go low. With Vcc applied to U31-5, a positive going external trigger from U35-10 will clock U31-1 high. The network of R24 and C6 will detect Vcc at power on and disable the module's interrupt capability. The high at U31-1 sets INT low and places a high at pin 12 of tri-state buffer U13. A returned high on INA then gates U13-11 high onto ID1. The controller will react to this high on ID1 by taking a reading. When data from the reading is accepted, ID0 will again go low, resetting U31 ready for the next external trigger. Triggers received prior to ID0 going low will be ignored.

608A-28. TROUBLESHOOTING

608A-29. Table 608A-2 gives a symptom analysis routine for troubleshooting the Isolator module.

608A-30. PARTS LIST

608A-31. Table 608A-3 gives a detailed parts breakdown of the Isolator (Option -08A). Refer to Section 5 of the Instruction Manual for ordering information.

Table 608A-2. Isolator Troubleshooting

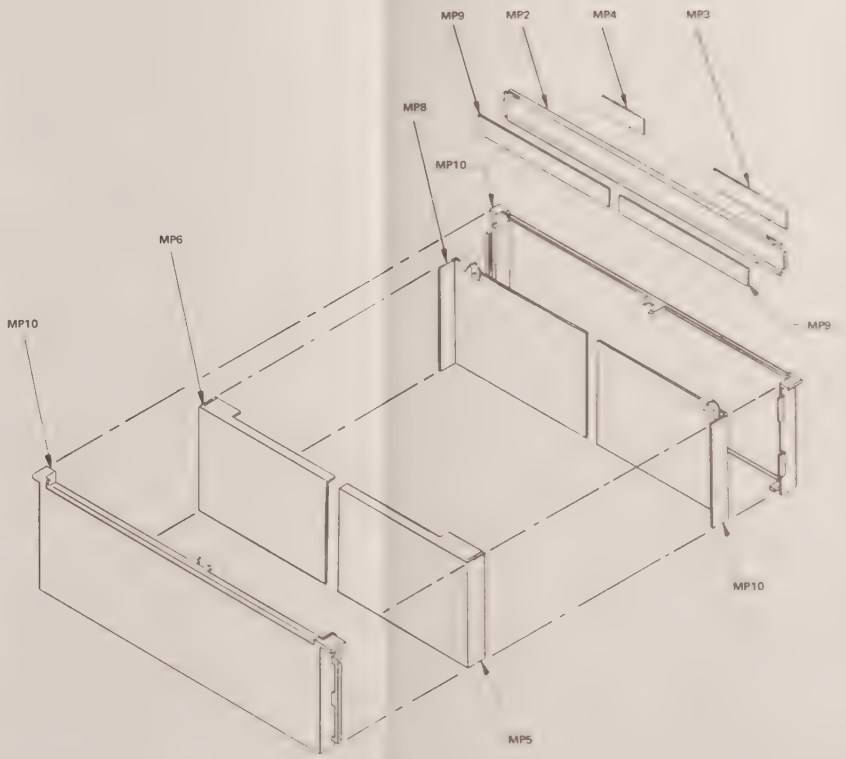
SYMPTOM	POSSIBLE FAILURE
No display at Power On	IC line held low U5, U12, U35
Display Bad	IC line held high U5, U12, U35
	ID line held high or low U1, U2, U13
UNGUARDED SECTION	
Error 9 at Power On	Oscillator check U11-10 Shift Register U31-1, U7 Not transferring pulses U4, core windings ACK bad U9, U12, Q1, U6, U7, U2, U8
Option Configuration Wrong	Address lines hung
Can't Call Proper Ranges	Data lines hung U1, U2, U3
Constant Bad Reading Displayed	ID7 not returned U8, U13, core winding U12, U10, U9, U35, U6.
GUARDED SECTION	
Error 9 or Configuration Wrong	U19-10, U16-1, U23-13 (Address, Data) U25, U19, U15, U24 (ACK) U24, U23 (Address)
Can't Call Proper Ranges	U16, U21, U18
Constant Bad Reading Displayed	U18, U26, U25, U19, U15 (ID7)

Table 608A-3. Isolator Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
FA	ISOLATOR ASSY (8502A-4181T)						
C1	CAP, MICA, 220PF+/-5%, 500V	170423	72136	DM15F221J	2		
C2	CAP, MICA, 18PF+/-5%, 500V	266585	72136	DM15C180J	1		
C3	CAP, MICA, 180PF+/-5%, 500V	148460	72136	DM15F181J	1		
C4	CAP, MICA, 220PF+/-5%, 500V	170423	72136	DM15F221J	REF		
C5	CAP, MICA, 68PF+/-5%, 500V	148510	72136	DM15F680J	1		
C6	CAP, TA, 39UF+/-20%, 6V	163915	56289	1SSD396X0006KA1	1		
C7	CAP, ELECT, 150UF-10/+50%, 16V	186296	73445	ET151X016A5	1		
C8	CAP, MICA, 27PF+/-5%, 500V	177998	72136	DM15E270J	2		
C9	CAP, MICA, 27PF+/-5%, 500V	177998	72136	DM15E270J	REF		
C10	CAP, CER, 0.22UF+/-20%, 50V	309849	71590	CW30C224K	3		
C11	CAP, CER, 0.0047UF+/-10%, 500V	106724	71590	CF-472	1		
C12	CAP, CER, 0.22UF+/-20%, 50V	309849	71590	CW30C224K	REF		
C13	CAP, CER, 0.22UF+/-20%, 50V	309849	71590	CW30C224K	REF		
C16	CAP, CER, 0.22UF+/-20%, 50V	309849	71590	CW30C224K	REF		
H1	SCREW, PHP, 4-40 X 5/8	145813	73734	19027	2		
MP1	SPRING, COIL	424465	83553	C0120-014-0380	2		
MP2	COVER, MODULE, CASE	486340	89536	486340	1		
MP3	DECAL CAUTION	454504	89536	454504	1		
MP4	DECAL, ISOLATOR/EXT TRIGGER	477570	89536	477570	1		
MP5	GUARD, FRONT LEFT	487298	89536	487298	1		
MP6	GUARD, FRONT RIGHT	487280	89536	487280	1		
MP7	GUARD REAR	383349	89536	383349	1		
MP8	GUARD, REAR, ISOLATOR	437947	89536	437947	1		
MP9	SHIELD, COVER	437939	89536	437939	1		
MP10	CASE HALF, MODULE	402990	89536	402990	1		
Q1	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1	1	
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904	1		
R1	RES, DEP CAR, 220+/-5%, 1/4W	342626	80031	CR251-4-5P 220ET	1		
R2	RES, DEP CAR, 10K+/-5%, 1/4W	348849	80031	CR251-4-5P10KT	9		
R3	RES, DEP CAR 47K+/-5%, 1/4W	348896	80031	CR251-4-5P47KT	2		
R4	RES, DEP CAR, 4.7K+/-5%, 1/4W	348821	80031	CR251-4-5P 4K7T	1		
R5	RES, DEP CAR, 10K+/-5%, 1/4W	348849	80031	CR251-4-5P10KT	REF		
R6	RES, DEP CAR, 1K+/-5%, 1/4W	343426	80031	CR251-4-5P1KT	2		
R7	RES, DEP CAR, 4.7K+/-5%, 1/4W	348821	80031	CR251-4-5P 4K7T	1		
R8	RES, DEP CAR, 10K+/-5%, 1/4W	348849	80031	CR251-4-5P10KT	REF		
R9	RES, DEP CAR, 10K+/-5%, 1/4W	348849	80031	CR251-4-5P10KT	REF		
R10	RES, DEP CAR, 10K+/-5%, 1/4W	348849	80031	CR251-4-5P10KT	REF		
R11	RES, DEP CAR, 10K+/-5%, 1/4W	348849	80031	CR251-4-5P10KT	REF		
R12	RES, DEP CAR, 10K+/-5%, 1/4W	348849	80031	CR251-4-5P10KT	REF		
R13	RES, DEP CAR, 10K+/-5%, 1/4W	348849	80031	CR251-4-5P10KT	REF		
R14	RES, DEP CAR, 150+/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R15	RES, DEP CAR, 470+/-5%, 1/4W	343434	80031	CR251-4-5P 470ET	1		
R17	RES, DEP CAR, 10K+/-5%, 1/4W	343426	80031	CR251-4-5P1KT	2		
R18	RES, DEP CAR, 100+/-5%, 1/4W	348771	80031	CR251-4-5P 100ET	1		
R20	RES, DEP CAR, 150+/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R21	RES, DEP CAR, 47K+/-5%, 1/4W	348896	80031	CR251-4-5P47KT	2		
R24	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
T1	INDUCTOR	437608	89536	437608	4		
T2	INDUCTOR	437590	89536	437590	4		
T3	INDUCTOR	437608	89536	437608	REF		
T4	INDUCTOR	437590	89536	437590	REF		
T5	INDUCTOR	437590	89536	437590	REF		
T6	INDUCTOR	437608	89536	437608	REF		
T7	INDUCTOR	437590	89536	437590	REF		
T8	INDUCTOR	437608	89536	437608	REF		
U1	IC, CMOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	3	1	
U2	IC, CMOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	REF		
U3	IC, TTL, MSI 8 BIT SHIFT REGISTER	293118	01295	SN74165N	2	1	
U4	IC, TTL, QUAD, 2INPUT HV INTRF NAND	408021	18324	N7426A	2	1	
U5	IC, CMOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE			
U6	IC, TTL, POS NAND GATES, HEX INVERTERS	393058	01295	SN74LS04N	2	1	
U7	IC, TTL, MSI 8 BIT SHIFT REGISTER	293118	01295	SN74165N	REF		
U8	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	3	1	
U9	IC, TTL, QUAD 2 IN NAND GATE	363580	01295	SN7400SN	1		
U10	IC, POS NAND GATES, TRIPLE 3 INPUT	393074	01295	SN74LS10N	1	1	
U11	IC, POS NOR GATES, TOTEM POLE OUTPUTS	393041	01295	SN74LS02N	2	1	
U12	IC, COS/MOS QUAD 2INPUT NOR GATES	355172	02735	CD4001AE	1		
U13	IC, CMOS, TR-STATE HEX NONINV BUFFERS	407759	12040	MM80C97N	2	1	

Table 608A-3. Isolator Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U14	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	REF		
U15	IC, TTL, QUAD, 2INPUT HV INTRF NAND	400021	18324	N7426A	REF		
U16	IC, SHIFT REGISTER, 8 BIT PARALLEL OUT	272138	01295	SN74164N	2	1	
U17	RES NETWORK, 10K +/-5%, 1/4W	355305	89536	355305	1	1	
U18	IC, CMOS, QUAD 2 INPUT AND GATES	400401	02735	CD4081B1	1	1	
U19	IC, POS NOR GATES, TOTEM POLE OUTPUTS	393041	01295	SN74LS02N	REF		
U20	IC, SHIFT REGISTER, 8 BIT PARALLEL OUT	272138	01295	SN74164N	REF		
U21	IC, CMOS, TR-STATE HEX NONINV BUFFERS	407759	12040	MM80C97N	REF		
U22	IC, COS/MOS, QUAD 2 INPUT NOR GATES	355172	02735	CD4001AE	1		
U23	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	REF		
U24	IC, TTL, POS NAND GATES, HEX INVERTERS	393058	01295	SN74LS04N	REF		
U25	IC, CMOS, TRIPLE 3 INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U26	IC, COS/MOS, QUAD 2 INPUT NOR GATES	355172	02735	CD4001AE	1		
U31	IC, CMOS, DUAL D FLIP FLOP	340117	04713	MC14013CP	1		
U32	IC, CMOS, FAST QUAD 2 IN NAND GATE	413211	12040	34011PC/4011PC	1		
U33	IC, CMOS, TRIPLE 3 IN NAND GATE	375147	04713	MC14023CP	1		
U35	IC, CMOS HEX SCHMITT TRIGGER	477810	12040	MM74C914N	1		



8502A–4181 Case

Figure 608A-3. Isolator Assembly

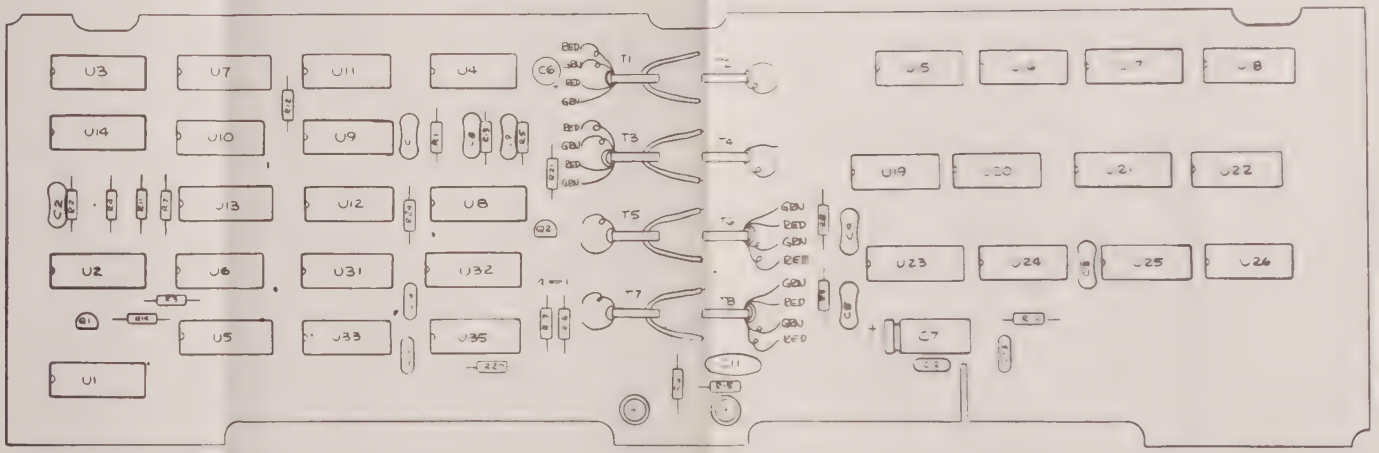


Figure 608A-3. Isolator Assembly (cont)

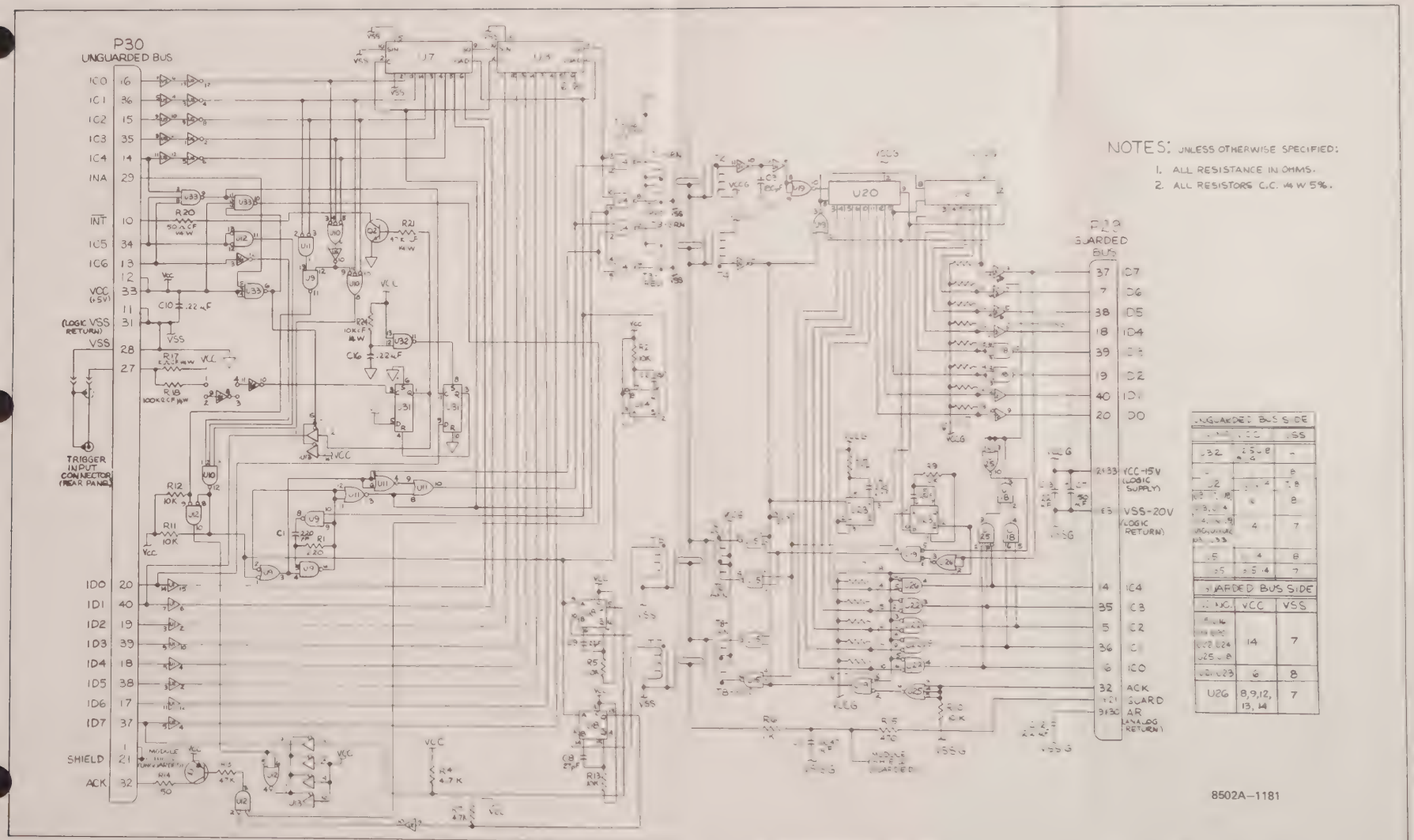


Figure 608A-3. Isolator Assembly (cont)

Option —09
AC/DC Converter (RMS)

609-1. INTRODUCTION

609-2. The AC/DC Converter (RMS) is used to provide accurate ac or ac + dc measurements without error due to waveform distortion. Measurements up to 1000 Vac in four ranges with a bandwidth of 10 Hz to 300 kHz may be made (input volt-hertz product not to exceed 2×10^7). Input impedance is 1 MΩ shunted by less than 100 pf.

609-3. SPECIFICATIONS

609-4. Table 609-1 lists the specifications for the true RMS Converter.

609-5. INSTALLATION

609-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the AC/DC Converter (RMS) module. The interconnect diagram in Section 8 contains a table listing permissable and preferred slots.

609-7. OPERATING NOTES

609-8. Operation of the front panel controls is the same as described in Section 2. An ac voltage on a dc level may be measured by depressing both the Vdc and the Vac function switches at the same time. The reading displayed will be the rms value of the two voltages combined. External reference inputs at the rear panel must be dc voltages only. The slow filter (FILTER LED illuminated) must be selected for full accuracy below 400 Hz.

609-9. THEORY OF OPERATION

609-10. The function of the RMS Converter is to accept signals from either the input terminals or the optional Current Shunts module and to convert the input signal to a dc level proportional to the rms value of the input. The dc output from the RMS Converter is routed on the Guarded Bus to the Active Filter module and then to the A/D Converter. True rms conversion is mathematically obtained by averaging the squared value of the input, then taking the square root ($V_{rms} = \sqrt{\overline{V_{in}^2}}$). Limitations to the realization of this mathematical formula using operational techniques are crest factor (ratio of peak value to rms value, limited by the dynamic range of the amplifiers), frequency response, and accuracy.

609-11. Input signals are applied to the Range Amplifier (Q1, U3) to be brought within the 1Vrms range. Refer to Figure 609-1. Before a signal can be operationally squared, it must be converted to an absolute value. Balance Amplifier (U4, Q10) performs this function by inverting and rectifying the signal from U3. Outputs from the Range Amplifier and the Balance Amplifier are applied through R33 and R31 to the summing node of the Squaring Amplifier (U5, Q11). Due to the ratio of R33 to R31, the inverted negative half-cycles from the Balance Amplifier are twice the amplitude of the negative half-cycles from the Range Amplifier. When summed, the waveform is the absolute value of the output from the Range Amplifier. The conversion to rms is performed by the Squaring Amplifier, Integrator, and Square Root Amplifier. Implementation of these functions depends on the logarithmic response of PN junctions. Since two PN junctions are used in each of two parts of a feedback loop, a double logarithmic response is generated ($2 \log X = \log X^2$). The Squaring Amplifier converts the signal to a current flowing through the emitters of two transistors, Q8A and Q12A. These two transistors are configured with two additional transistors, Q12B and Q8B, in a feedback loop which constrains the output voltage to be the square root of the integral of the square of the current flowing in Q8A and Q12A.

Table 609-1. AC/DC Converter (RMS) Specifications

ACCURACY

(Refer to Section 1 for required environmental conditions)

Accuracy (0.1% of Range to Full Scale)

Frequency	24 Hours			90 Days			1 Year		
	% of Input	+% FS AC	+% FS AC + DC	% of Input	+% FS AC	+% FS AC + DC	% of Input	+% FS AC	+% FS AC + DC
DC	0.075	—	0.03	0.1	—	0.03	0.2	—	0.06
10 Hz to 20 Hz	0.75	0.04	0.06	1.0	0.04	0.06	2.0	0.08	0.12
20 Hz to 50 Hz	0.35	0.012	0.03	0.5	0.012	0.03	1.0	0.04	0.06
50 Hz to 10 kHz	0.075	0.012	0.03	0.1	0.012	0.03	0.2	0.04	0.06
10 kHz to 30 kHz	0.15	0.04	0.06	0.2	0.04	0.06	0.4	0.08	0.12
30 kHz to 50 kHz	0.2	0.1	0.12	0.3	0.1	0.12	0.6	0.6	0.25
50 kHz to 100 kHz	0.75	0.3	0.3	1.0	0.3	0.3	2.0	0.6	0.6
100 kHz to 300 kHz	1.5	0.5	0.5	2.0	0.5	0.5	4.0	1.0	1.0

NOTES: 1. *Slow Filter must be used for full accuracy below 400 Hz.*

2. *Volt-Hertz product not to exceed* 2×10^7

3. *For inputs above 500V, multiply accuracy by:* $\left(\frac{2000V + V\,in}{2000V}\right)$

INSTRUMENT OPERATING CHARACTERISTICS

INPUT CHARACTERISTICS

Range	Full Scale	Resolution		Impedance
		Normal	High	
1V	2.5V	10 uV	1 uV	1 MΩ, <100 pF
10V	20V	100 uV	10 uV	
100V	160V	1 mV	100 uV	
1000V	1000V	10 mV	1 mV	

MAXIMUM INPUT

1000V rms of 2×10^7 volt-hertz product, whichever is less.

TEMPERATURE COEFFICIENT

(0°C to 18°C and 28°C to 50°C)

AC* Only ±(40 ppm or Reading + 20 ppm f.s.)/°C
AC* + DC ±(40 ppm of Reading + 40 ppm f.s.)/°C

**Frequencies <10 kHz*

SETTLING TIME (To within 0.1%)

100 ms, Fast Filter
500 ms, Slow Filter

COMMON MODE REJECTION

(100Ω Unbalance)

120 dB, dc to 60 Hz

CREST FACTOR

>7 at full scale, increasing down scale by:

$$7 \times \sqrt{\frac{V_{Range}}{V_{Input}}}$$

DIGITIZING

Same as dc volts

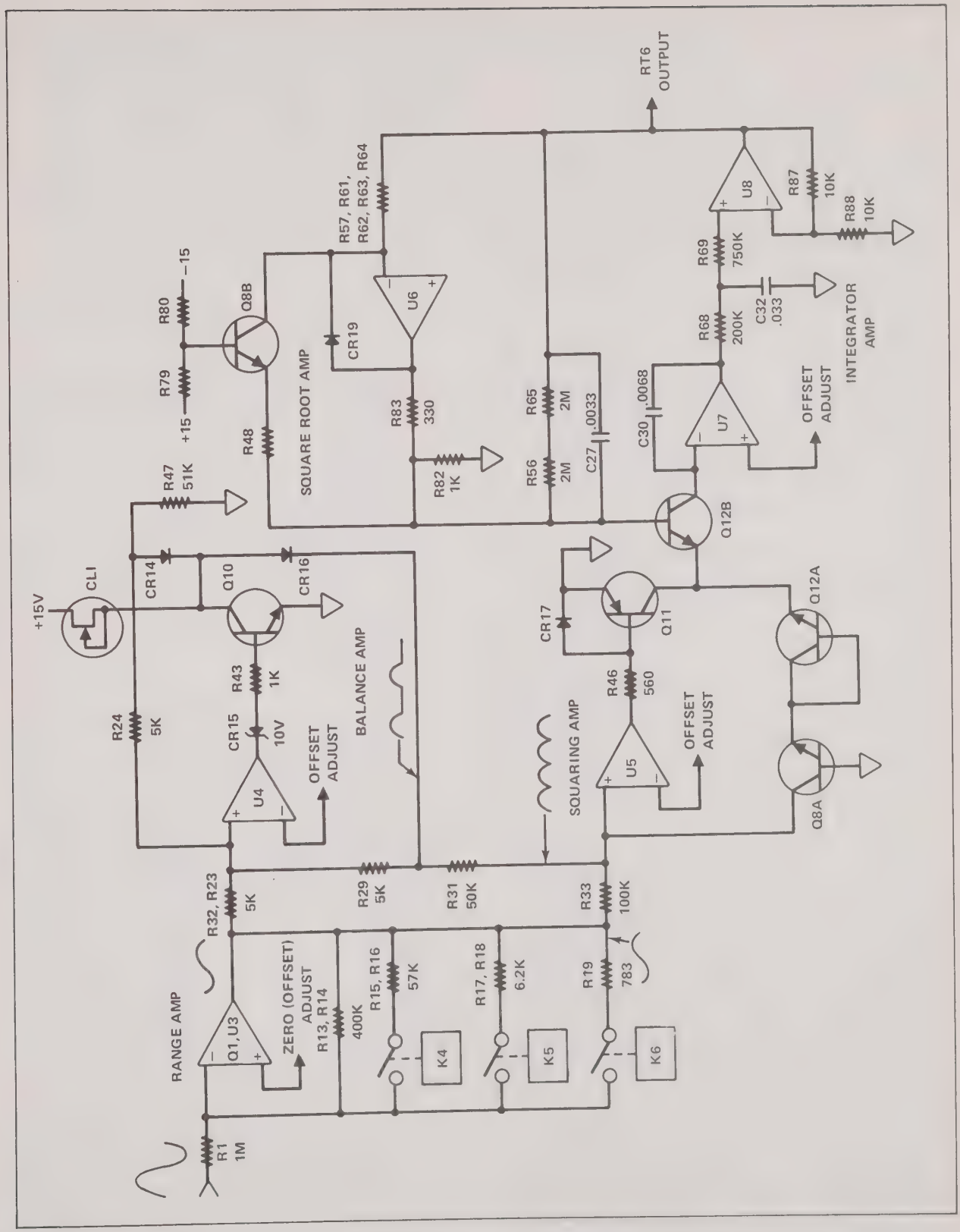


Figure 609-1. AC/DC Converter (RMS)

609-12. Circuit Description

609-13. Refer to the schematic for the following discussion.

609-14. RANGE AMPLIFIER

609-15. The Range Amplifier is an inverting amplifier with gain control provided by switching feedback impedances. Feedback impedances are controlled by relays K4, K5, or K6, and consist of parallel resistors and capacitors adjusted for proper gain and frequency response. Relays K1, K2, and K7 control the input to the amplifier. K1 is energized for inputs from the input terminals. K7 is energized for inputs from the Current Shunts module. K2 is energized when selecting ac + dc measurements. Gain of the amplifier is set for a 1V rms output with a full-scale sine wave input with the exception of the 1000V range in which the full-scale output is .8V rms. Q1 and U3 provide the forward gain of the amplifier. CR6, CR7, CR21, and CR22 provide input protection. Q2 drives the guard for the summing node of the operational amplifier.

609-16. BALANCE AMPLIFIER

609-17. The Balance Amplifier is an inverting, unity-gain amplifier with diodes in the feedback paths to provide rectification. CL1 and Q10 are configured as a current source driven by U4. A high impedance current source is used to minimize the effects of the diodes on the gain of the amplifier. Due to the unity gain of the inverting amplifier and the ratio of R33 to R31, the negative half-cycles from the Range Amplifier are summed with positive half-cycles having twice the amplitude from the Balance Amplifier. The result is the absolute value of the output from the Range Amplifier. Q6 is used to extend the frequency response of the amplifier.

609-18. COMPUTATION

609-19. The Squaring Amplifier, Square Root Amplifier, and Integrator Amplifier work together to perform the rms conversion. This is accomplished by regulating the current in four transistors, Q8A, Q12A, Q8B, and Q12B, matched for temperature coefficient and response characteristics. The Squaring Amplifier sums the outputs from the Range Amplifier and the Balance Amplifier such that the current flowing through its feedback path (Q8A, Q12A) is proportional to the absolute value of the input signal. Forward gain of the amplifier is provided by U5 and Q11 with Q7 extending the frequency response.

609-20. Q12B is configured such that the integral of its collector current is the output voltage. U7 and U8 integrate the collector current of Q12B. Q8B is configured such that its collector current is proportional to the output voltage. The current through Q8B controls the gain of U6, the Square Root Amplifier, which in turn partially controls the current flowing in Q12B. The integrating time constant of U7 and U8 is determined by R56 and R65 in parallel with C27 or C27 plus C28, depending on which filter is selected from the front panel. The proportionality constant of the converter is such that a full-scale input produces a 20V output on RT6.

609-21. MAINTENANCE

609-22. Performance Test

609-23. Use the following procedure as a performance determination of the AC/DC Converter (RMS).

1. Select AC Volts and Autoranging.
2. Connect the AC Calibrator system output to the input terminals.
3. Sequentially apply the input voltages and frequencies listed in Table 609-2 and verify that the instrument reading falls within the specified limits.
4. Disconnect the AC Calibrator and connect the DC Calibrator.
5. Select an output from the DC Calibrator of + 10.0000V dc.
6. Verify that the display reads between 9.9840 and 10.0160.
7. Reverse the leads at the output of the DC Calibrator.
8. Verify that the display reads between 9.9840 and 10.0160.

Table 609-2.

INPUT		8500A READING	
FREQ	VOLTAGE	LOW	HIGH
10 kHz	1 V	0.99870	1.00130
50 kHz	1 V	0.99450	1.00550
10 kHz	10 V	9.9876	10.0124
50 kHz	10 V	9.9500	10.0500
10 kHz	100 V	99.881	100.119
50 kHz	100 V	99.540	100.460
10 kHz	1000 V	998.48	1001.52

609-24. Calibration

609-25. Before calibrating the RMS Converter, remove the Calibration Memory and allow a one hour warm-up. After calibration is complete, reinstall the Calibration Memory and enter new values at the zero and cardinal points.

609-26. Use the following procedure to calibrate the RMS Converter. All adjustments are on the AC/DC

Converter (RMS) module. Ensure that the DC Volts function is within tolerance (Section 4).

609-27. RANGE ZERO

1. Connect a test DVM between TP5 (HI) and TP1 (LO) and short the input terminals.
2. Select the 10V range.
3. Adjust R12, Range Zero, for a reading on the test DVM of 0 ± 30 μV.
4. Remove the short connecting the input terminals and the test DVM.

609-28. BALANCE ADJUSTMENTS

1. Apply –0.200000V dc to the input terminals from a DC Calibrator. Record the absolute value of the reading.
2. Reverse the polarity of the input to +0.200000.
3. Adjust R42 Balance Zero twice as far as required to equal the absolute value recorded in step 1.
4. Repeat steps 1, 2, and 3 until the difference between the absolute values is less than 10 digits without an adjustment.
5. Select the Cal mode of operation, i.e., the CAL switch ON and the CAL indicator illuminated.

NOTE

The Cal mode prevents the instrument from overranging during adjustments at the range upper limit. Ignore the cal digit while making check or adjustments for the remainder of this procedure.

6. Apply –20.00000V dc to the input terminals from a DC Calibrator. Record the absolute value of the reading.
7. Reverse the polarity of the input to +20.00000.
8. Adjust R32 Balance Gain to the absolute value recorded in step 6.
9. Repeat steps 6, 7, and 8 until the difference between the absolute values is less than 10 digits without an adjustment.

609-29. ZERO ADJUST

1. Select the VAC function and the IV range.
2. Apply an input of 2.5 mV ac at 500 Hz from the AC Calibrator system.
3. Adjust R45 AC ZERO for a reading between 0.00245 and 0.00255.

609-30. ACCURACY TESTS

1. Select the 1000V range.
2. Apply an input of 500V ac at 500 Hz from the AC Calibrator system.
3. Adjust R64 for a reading between 499.990 and 500.010.
4. Increase the input frequency to 50 kHz.
5. Adjust C4 for a reading between 499.990 and 500.010.
6. Apply an input of 2.5V ac at 500 Hz from the AC Calibrator system.
7. Select the IV range.
8. Adjust R14 for a reading between 2.49975 and 2.50025.
9. Increase the input frequency to 50 kHz.
10. Adjust C9 for a reading between 2.49975 and 2.50025.
11. Verify that the values given in steps 1 through 8 of Table 609-3 are within the stated tolerances for the voltage and frequency listed.
12. Select the 10V range.
13. Apply an input of 20V ac at 500 Hz from the AC Calibrator system.
14. Adjust R16 for a reading between 19.9980 and 20.0020.
15. Increase the input frequency to 50 kHz.
16. Adjust C11 for a reading between 19.9980 and 20.0020.
17. Select the 100V range.
18. Apply an input of 160V ac at 500 Hz from the AC Calibrator system.
19. Adjust R18 for a reading between 159.985 and 160.015.
20. Increase the input frequency to 50 kHz.
21. Adjust C14 for a reading between 159.985 and 160.015.
22. Select the 1000V range.
23. Apply an input of 1000V ac at 10 kHz from the AC Calibrator system.
24. Monitor the reading for 30 seconds. At the end of that time the reading should be between 999.20 and 1000.80.

25. Verify that the values given in steps 9 through 12 of Table 609-3 are within the stated tolerances for the voltage and frequency listed.

Table 609-3. RMS AC Tests

INPUT				READING		
Step	Range	Voltage	Frequency	Minimum	Nominal	Maximum
1	1V	2.5V	300k	2.49000	2.50000	2.51000
2	1V	2.5V	20k	2.49925	2.50000	2.50075
3	1V	2.5V	50	2.49900	2.50000	2.50100
4	1V	2.5V	100k	2.48750	2.50000	2.51250
5	1V	0.25V	100k	0.24125	0.25000	0.25875
6	1V	2.5 mV	50k	0.00175	0.00250	0.00325
7	1V	2.5 mV	500	0.00225	0.00250	0.00275
8	1V	0.8V	500	0.79960	0.80000	0.80040
9	100V	160V	300k	157.000	160.000	163.000
10	10V	20V	300k	19.6000	20.0000	20.4000
11	1V	0.8V	300k	0.77500	0.80000	0.82500
12	1V	0.2V	300k	0.18800	0.20000	0.21200

609-31. Troubleshooting

609-32. Troubleshooting procedures for the RMS Converter follow the format used in Section 4. Table 609-4 assures that the problem actually is in the RMS Converter. Figure 609-2 gives a symptom analysis approach to troubleshooting, with possible failures listed in order of probability, and gives the address and data field used to set up the module. DO NOT remove modules with the power on.

609-33. PARTS LIST

609-34. Table 609-5 gives a parts breakdown for the AC/DC Converter (RMS). Refer to Section 5 for ordering information.

⊗ CAUTION

Indicated devices are subject to damage by static discharge.

Table 609-4. AC Converter Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do the DC Performance Test (Section 4).		Section
2	Is DC Volts within tolerance?	3	4
3	Is the Calibration Memory module installed?	4	6
4	Remove the Calibration Memory module. Is AC OK?	5	6
5	Bad Calibration Memory. Go to Section 604.		
6	Is Isolator installed?	7	10
7	Replace Isolator with Bus Interconnect/Monitor pcb.		
8	Is AC OK?	9	10
9	Bad Isolator. Go to Section 608.		
10	Remove DC Signal Conditioner. Is AC OK?	11	12
11	DC Signal Conditioner interfering with AC. The problem in the DC Signal Conditioner is one of the following: 1. Digital Logic Bad, 2. K1 or K2 shorted, 3. Q6, Q7, Q8 Bad.		
12	Install Bus Interconnect/Monitor if not already installed.		
13	Check power supply voltages as follows: VA1 = +14.25 to 15.75V VA2 = −14.25 to −15.75V VA3 = +29 to 32V VA4 = −29 to −32V Vcc = −15V Difference = 4.9 Vss = −20V to 5.2		
14	Are the supply voltages OK?	15	Section 4
15	Go to Figure 609-2.		

Figure 609-2. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
High reading on display with open inputs, 1000V range	C24 misadjusted, Q9, Q10, U4
High frequency (300 kHz) bad	C24 misadjusted or bad, U3
Reading not stable	U3, U4
Crest factor bad	Q8, Q12
AC breaks down (overload source above 500V)	K7
AC out of tolerance in slow filter mode	Q13 and Q14, Q16 and Q17
One range bad	Digital Logic, Range Relays, CR14, CR16
All ranges bad	U3, Q1, U5, Q7, U7, U8, K8, K1
Excessive noise	U3, Q2
Display blanks	U1, U10

The largest single failure items tend to be relays and electrolytic capacitors

Note: If Q8 or Q12 is replaced, the module should be returned to the factory (Attn. Parts) for temperature compensation and adjustment of R38.

Address IC 0, 2, 4 high

ID0 = 0, ID1 = 0 — DC Coupled AC

ID0 = 1, ID1 = 0 — AC Volts

ID0 = 0, ID1 = 1 — RT1 input for AC Current

ID2 = 0 — Filter On

ID3 = 0 — 10V range

ID4 = 0 — 100V range

ID5 = 0 — 1000V range

ID3 through ID5 = 1 — 1V range

Table 609-5. AC/DC Converter (RMS)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Ⓧ	**AC/DC CONVERTER (RMS) ASSEMBLY TESTED** **Figure: 609-3**						
C1	Cap, film, 0.22 uF ±20%, 1200V	268904	84411	JF-65	1		
C2	Cap, porc, 2.2 pF ±0.25%, 1700V ac	340273	95275	VY10CA2R2CA	1		
C3	Cap, mica, 220 pF ±5%, 500V	170423	72136	DM15F221J	1		
C4, C9	Cap, var, 0.25 –1.5 pF, 2000V	218206	74970	273-0001-001	2	1	
C7, C34, C39	Cap, film, 0.10 uF ±10%, 100V	393439	89536	393439	3		
C8	Cap, porc, 5.1 pF ±0.25 pF, 1000V	347948	95275	VY13C5R1C	1		
C10	Cap, mica, 43 pF ±1%, 500V	277202	72136	DM15E430F	1		
C11	Cap, var, 0.8 –10 pF, 200V	229930	91293	JMC5201	1	1	
C12	Cap, film, 0.047 uF ±10%, 250V	162008	89536	162008	1		
C13	Cap, mica, 390 pF ±1%, 500V	355339	72136	DM15F391F	1		
C14	Cap, var, cer, 9–35 pF, 350V	289637	72982	538-006D-9-35	1	1	
C15	Cap, mica, 3600 pF, ±2%, 500V	176644	72136	DM19F362G	1		
C16, C18, C20, C26, C31, C45	Cap, mica, 27 pF ±5%, 500V	177998	72136	DM15E270J	6		
C17	Cap, mica, 8 pF ±10%, 500V	216986	72136	DM15C080K	1		
C19, C22	Cap, mica, 1000 pF ±5%, 500V	148387	72136	DM19F102J	2		
C21	Cap, mica, 2 pF ±0.5 pF, 500V	175208	72136	DM15C020D	1		
C23, C36, C37	Cap, Ta, 15 uF ±10%, 20V	153056	56289	150D156X 9020B	3		
C24	Cap, var, cer 1.7 –10 pF, 250V	321109	91293	9301	1	1	
C25	Cap, mica, 390 pF ±5%, 500V	148437	72136	DM15F391J	1		
C27, C42	Cap, film, 0.0033 uF ±10%, 50V	402867	06001	75F1R5A333	2		
C28	Cap, polyester, 0.01 uF ±10%, 400V	402818	89536	402818	1		
C29, C41	Cap, film, 0.022 uF ±10%, 250V	234484	89536	234484	2		
C30	Cap, film, 0.0068 uF ±10%, 200V	106070	56289	192P68202	1		

Table 609-5. AC/DC Converter (RMS) (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C32, C35	Cap, film, 0.033 uF ±10%, 250V	234492	89536	234492	2		
C33	Cap, film, 0.0047 uF ±10%, 50V	260844	06001	75F1R5A347	1		
C40	Cap, mica, 15 pF ±5%, 500V	148569	72136	DM15C150J	1		
C43	Cap, Ta, 6.8 uF ±20%, 35V	363713	56289	196D85X0035 KA1	1		
CL1	Diode, FET, CUR REG	285106	07910	TCR5309	1	1	
CR2 thru CR5,CR8, CR9, CR10, CR17	Diode, Hi-speed Switching	203323	07910	1N4448	8	2	
CR6, CR7, CR14, CR16, CR20, CR25	Diode, lo-cap-lo-leak	375907	07263	FD7222	6	2	
CR11, CR15, CR18, CR24	Diode, zen, uncompn	246611	07910	1N961A	4	1	
CR19	Diode, rectifier, Si	180554	07910	CD12599	1	1	
CR21, CR22	Diode, zen, uncompn	260695	07910	1N754A	2	1	
K1, K7	Relay, coil	272070	71707	UD-L-P	2		
K1, K7	Switch, dry reed	219097	95348	MR5972	2		
K2	Coil, reed relay	269019	71707	U-6-P	1		
	Switch, dry reed (use with K1, K2, K7)	284091	95348	MR138MOD	3		
	Foil (use with K1, K2, K7)	313833	89536	313833	5		
K4, K5, K6, K8	Relay dry reed	357566	71707	UF40069	4		
Q1	Xstr, Dual, FET, N-channel (selected)	267963	89536	267963	1	1	
Q2, Q6, Q7	Xstr, FET, N-channel	343103	89536	343103	3	1	

Table 609-5. AC/DC Converter (RMS) (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q4, Q10, Q18, Q19	Xstr, NPN, Si	218396	04713	2N3904	4	1	
Q8, Q12	Xstr, Matched Set	341057	89536	341057	2	1	
Q9	Xstr, NPN, Si	218081	89536	218081	1	1	
Q11	Xstr, PNP, Si	195974	04713	2N3906	1	1	
Q13, Q16, Q17	Xstr, FET, N-channel	288324	89536	288324	3	1	
Q14	Xstr, FET, N-channel	393314	89536	393314	1	1	
Q15	Xstr, PNP, Si	218388	07263	2N3645	1	1	
Q20	Xstr, PNP, Si	226290	04713	MPS3640	1	1	
R1	Res, mf, 1M ±0.1%, 1W	340265	03888	PME75	1		
R2	Res, comp, 22k ±5%, 1/4W	148130	01121	CB2235	1		
R3	Res, mf, 2.0k ±1%, 1/8W	235226	91637	MFF1-82001F	1		
R6, R7, R31	Res, mf, 50k ±0.1%, 1/8W	340257	91637	MFF1-85002B	3		
R8	Res, mf, 48.7k ±1%, 1/8W	267385	91637	MFF1-84872F	1		
R9, R35, R53, R59, R67, R70	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	6		
R10	Res, comp, 470 ±5%, 1/4W	147983	01121	CB4715	1		
R11	Res, comp, 12k ±5%, 1/4W	159731	01121	CB1235	1		
R12, R42, R45	Res, var, cermet, 1M ±10%, 1/2W	334722	89536	334722	3	1	
R13	Res, mf, 399k ±0.1%, 1/8W	417212	91637	MFF1-83993B	1		
R14	Res, var, cermet, 2k ±10%, 1/2W	285163	89536	285163	1	1	
R15	Res, mf, 56.89k ±0.1%, 1/8W	417220	91637	MFF1-856891B	1		
R16	Res, var, cermet, 500 ±10%, 1/2W	291120	89536	291120	1	1	
R17	Res, mf, 6324 ±0.1%, 1/8W	417238	91637	MFF1-86324B	1		
R18, R32	Res, var, cermet, 50 ±10%, 1/2W	285122	89536	285122	2	1	
R19	Res, mf, 782.8 ±0.1%, 1/8W	417246	91637	MFF1-8782R8B	1		

Table 609-5. AC/DC Converter (RMS) (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R20, R84	Res, comp, 4.7k ±5%, 1/4W	148072	01121	CB4725	2		
R21	Res, comp, 100 ±5%, 1/4W	147926	01121	CB1015	1		
R22	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	1		
R23	Res, mf, 4.975k ±0.1%, 1/8W	340232	91637	MFF1-84975B	1		
R24	Res, comp, 5.1k ±5%, 1/4W	193342	01121	CB5125	1		
R25	Res, comp, 3k ±5%, 1/4W	193508	01121	CB3025	1		
R26	Res, comp, 3.9k ±5%, 1/4W	148064	01121	CB3925	1		
R27, R58	Res, mf, 1M ±1%, 1/8W	268797	91637	MFF1-81004F	2		
R28	Res, mf, 121 ±1%, 1/8W	343160	91637	MFF1-81210F	1		
R29	Res, mf, 5k ±0.1%, 1/8W	340240	91637	MFF1-85001B	1		
R30, R37, R40	Res, comp, 5.6k ±5%, 1/4W	148080	01121	CB5625	3		
R33	Res, mf, 100k ±0.1%, 1/8W	340166	91637	MFF1-81003B	1		
R34	Res, mf, 35.7k ±1%, 1/8W	288480	91637	MFF1-83572F	1		
R36	Res, comp, 82 ±5%, 1/4W	149484	01121	CB8205	1		
R38	Res, var, cermet, 3 ±25%, 1/2W	347963	32997	3329H-J81-3R0	1	1	
R41	Res, comp, 56k ±5%, 1/4W	170738	01121	CB5635	1		
R43, R82	Res, comp, 1k ±5%, 1/4W	148023	01121	CB1025	2		
R44	Res, comp, 9.1k ±5%, 1/4W	193318	01121	CB9125	1		
R46, R54, R60	Res, comp, 560 ±5%, 1/4W	147991	01121	CB5615	3		
R47	Res, comp, 51k ±5%, 1/4W	193334	01121	CB5135	1		
R49, R83	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	2		
R50	Res, comp, 22k ±5%, 1/4W	147884	01121	CB2235	1		
R51	Res, comp, 47k ±5%, 1/4W	148163	01121	CB4735	1		
R52	Res, mf, 4.02M ±1%, 1/4W	417253	91637	MFF1-440203F	1		
R55, R66	Res, var, cermet, 1M ±10%, 1/2W	276691	89536	276691	2	1	
R56, R65	Res, mf, 2M ±0.25%, 1/2W	327502	91637	MFF1-22004C	2		
R57	Res, mf, 930k ±0.25%, 1/4W	417345	91637	MFF1-49303C	1		

Table 609-5. AC/DC Converter (RMS) (Continued)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R61	Res, mf, 17.4k ±1%, 1/8W	236802	91637	MFF1-81742F	1		
R62	Res, mf, 34k ±1%, 1/8W	261602	91637	MFF1-83402F	1		
R63	Res, mf, 68.1k ±1%, 1/8W	236828	91637	MFF1-86812F	1		
R64	Res, var, cermet, 20k ±10%, 1/2W	291609	89536	291609	1	1	
R68	Res, comp, 200k ±5%, 1/4W	248781	01121	CB2045	1		
R69	Res, comp, 750k ±5%, 1/4W	221937	01121	CB7545	1		
R71	Res, comp, 470k ±5%, 1/4W	188441	01121	CB4745	1		
R72	Res, comp, 22k ±5%, 1/4W	148130	01121	CB2235	1		
R73	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	1		
R74, R85	Res, comp, 20k ±5%, 1/4W	221614	01121	CB2035	2		
R78	Res, mf, 10 ±1%, 1/8W	268789	91637	MFF1-8A100F	1		
R86, R90	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	2		
R87, R88, R92	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	3		
U1	⊗ IC, Dgtl, C-MOS, quad, 2-input, NAND gates	375147	02735	CD4023AE	1	1	
U2	IC, TTL, hex inverter, buffer/driver	288605	01295	SN7416N	1	1	
U3	IC, Lin, Op-Amp	329912	12040	LM318H	1	1	
U4	IC, Op-Amp	225961	24355	AD3092	1	1	
U5	IC, Lin, Op-Amp	288928	12040	LM308AH	1	1	
U6, U7	IC, Lin, Op-Amp	284760	12040	LM308H	2	1	
U8	IC, Op-Amp	381889	12040	LM201A	1	1	
U9	⊗ IC, Dgtl, C-MOS, hex, inverter/buffer	381848	02735	CD4049AE	1	1	
U10	⊗ IC, Dgtl, C-MOS, hex "D" flip-flop	404509	12040	MM74C174N	1	1	
U11	⊗ IC, Dgtl, C-MOS, quad 2-input, NAND gates	355198	02735	CD4011AE	1	1	
	Casehalf, Module	402990	89536	402990	2		
	Cover, module case	402974	89536	402974	1		
	Decal	413393	89536	413393	1		
	Guard, front	383356	89536	383356	1		

Table 609-5. AC/DC Converter (RMS) (Concluded)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	Guard, rear	383364	89536	383364	1		
	Heatsink	347740	89536	347740	1		
	Insulator, RMS Shield	426932	89536	426932	1		
	Shield, cover	411934	89536	411934	1		
	Shield, input, RMS conv	390484	89536	390484	1		
	Shield, RMS conv	416214	89536	416214	1		
	Socket, comp, lead	343285	00779	2-331272-6	5		
	Spacer, Xstr, Mtg (use with CL1)	175125	07047	10172-DAP	1		
	Spacer, Xstr, Mtg (use with Q15)	152207	07047	10123DAP	1		

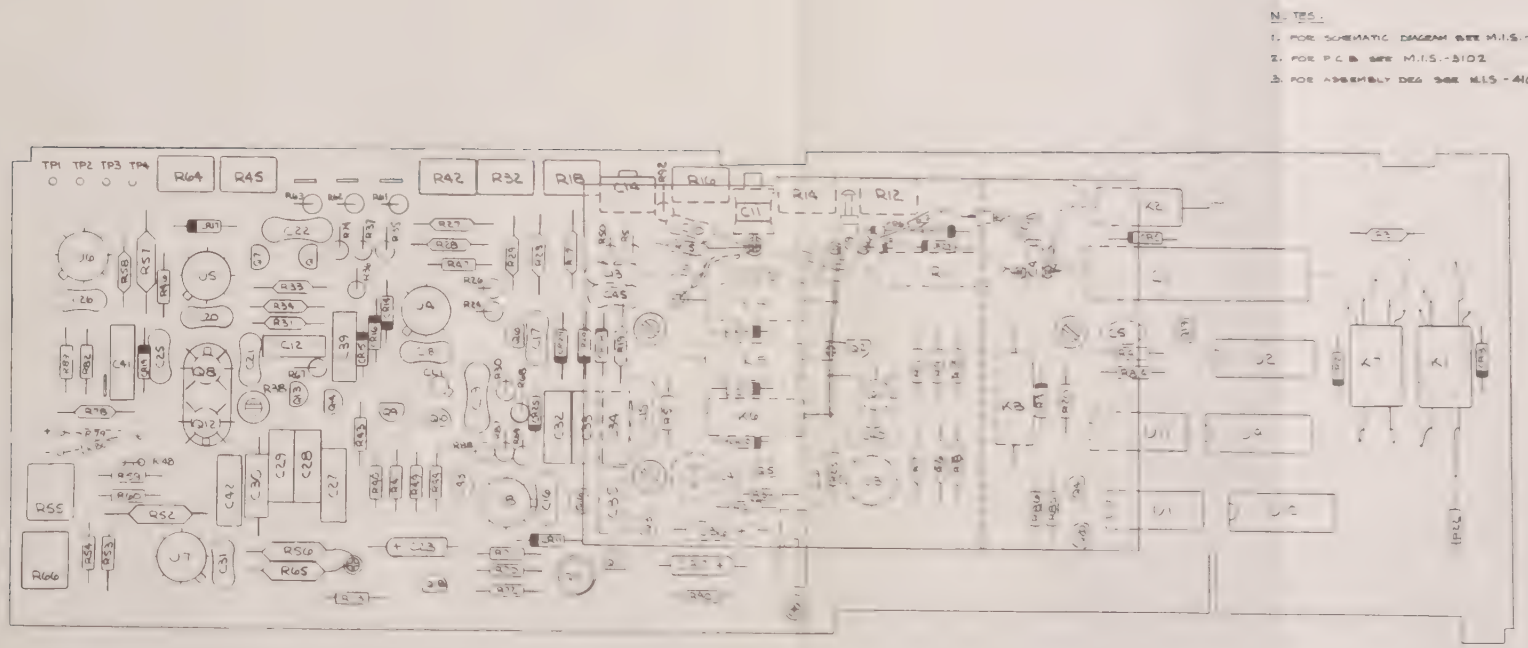


Figure 609-3. AC/DC Converter (RMS) Assembly (M.I.S.-1702)

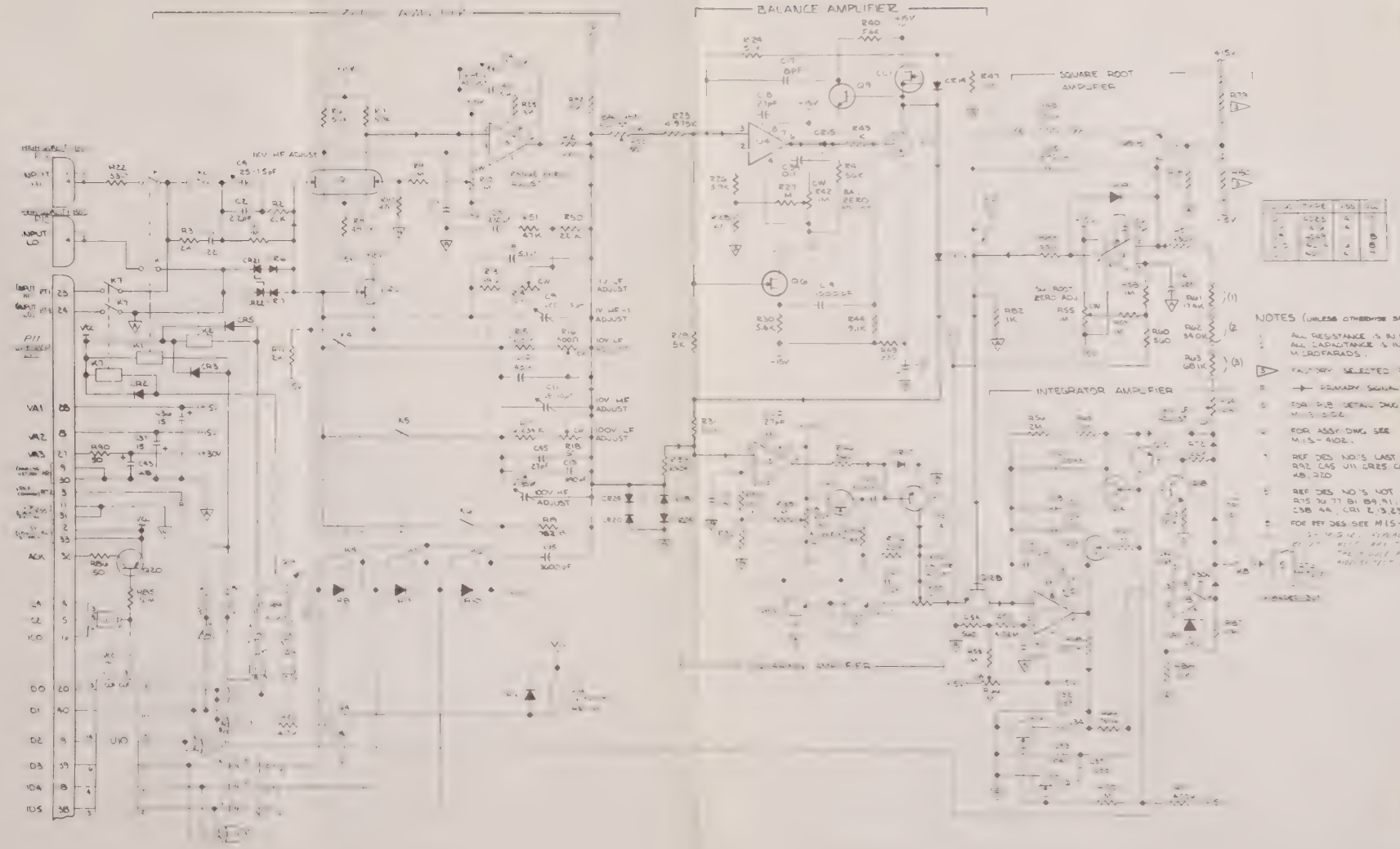


Figure 609-4. AC/DC Converter (RMS) (M.I.S.-1102)

Option —09A
AC/DC Converter (RMS)

609A-1. INTRODUCTION

609A-2. The AC/DC Converter (RMS) is used to provide accurate ac or ac + dc measurements without error due to waveform distortion. Measurements up to 1000 Vac in four ranges with a bandwidth of 10 Hz to 300 kHz may be made (input volt-hertz product not to exceed 2×10^7). Input impedance is 1 MΩ shunted by less than 100 pf.

609A-3. SPECIFICATIONS

609A-4. Table 609-1 lists the specifications for the true RMS Converter.

609A-5. INSTALLATION

609A-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the AC/DC Converter (RMS) module. The interconnect diagram in Section 8 contains a table listing permissable and preferred slots.

609A-7. OPERATING NOTES

609A-8. Operation of the front panel controls is the same as described in Section 2. An ac voltage on a dc level may be measured by depressing both the Vdc and the Vac function switches at the same time. The reading displayed will be the rms value of the two voltages combined. External reference inputs at the rear panel must be dc voltages only. The slow filter (FILTER LED illuminated) must be selected for full accuracy below 400 Hz.

609A-9. THEORY OF OPERATION

609A-10. The function of the RMS Converter is to accept signals from either the input terminals or the optional Current Shunts module and to convert the input signal to a dc level proportional to the rms value of the input. The dc output from the RMS Converter is routed on the Guarded Bus to the Active Filter module and then to the A/D Converter. True rms conversion is mathematically obtained by averaging the squared value of the input, then taking the square root ($V_{rms} = \sqrt{\overline{V_{in}^2}}$). Limitations to the realization of this mathematical formula using operational techniques are crest factor (ratio of peak value to rms value, limited by the dynamic range of the amplifiers), frequency response, and accuracy.

609A-11. Input signals are applied to the Range Amplifier (Q1, U3) to be brought within the 1V rms range. Refer to Figure 609A-1. Before a signal can be operationally squared, it must be converted to an absolute value. Balance Amplifier (U4, Q10) performs this function by inverting and rectifying the signal from U3. Outputs from the Range Amplifier and the Balance Amplifier are applied through R33 and R31 to the summing node of the Squaring Amplifier (U5, Q11). Due to the ratio of R33 to R31, the inverted negative half-cycles from the Balance Amplifier are twice the amplitude of the negative half-cycles from the Range Amplifier. When summed, the waveform is the absolute value of the output from the Range Amplifier. The conversion to rms is performed by the Squaring Amplifier, Integrator, and Square Root Amplifier. Implementation of these functions depends on the logarithmic response of PN junctions. Since two PN junctions are used in each of two parts of a feedback loop, a double logarithmic response is generated ($2 \log X = \log X^2$). The Squaring Amplifier converts the signal to a current flowing through the emitters of two transistors, Q8A and Q12A. These two transistors are configured with two additional transistors, Q12B and Q8B, in a feedback loop which constrains the output voltage to be the square root of the integral of the square of the current flowing in Q8A and Q12A.

CHECK ERRATA #5

Table 609A-1. AC/DC Converter (RMS) Specifications

ACCURACY

(Refer to Section 1 for required environmental conditions)

Accuracy (0.1% of Range to Full Scale)

Frequency	24 Hours			90 Days			1 Year		
	% of Input	+% FS AC	+% FS AC + DC	% of Input	+% FS AC	+% FS AC + DC	% of Input	+% FS AC	+% FS AC + DC
DC	0.075	–	0.03	0.1	–	0.03	0.2	–	0.06
10 Hz to 20 Hz	0.75	0.04	0.06	1.0	0.04	0.06	2.0	0.08	0.12
20 Hz to 50 Hz	0.35	0.012	0.03	0.5	0.012	0.03	1.0	0.04	0.06
50 Hz to 10 kHz	0.075	0.012	0.03	0.1	0.012	0.03	0.2	0.04	0.06
10 kHz to 30 kHz	0.15	0.04	0.06	0.2	0.04	0.06	0.4	0.08	0.12
30 kHz to 50 kHz	0.2	0.1	0.12	0.3	0.1	0.12	0.6	0.6	0.25
50 kHz to 100 kHz	0.75	0.3	0.3	1.0	0.3	0.3	2.0	0.6	0.6
100 kHz to 300 kHz	1.5	0.5	0.5	2.0	0.5	0.5	4.0	1.0	1.0

NOTES:

1. Slow Filter must be used for full accuracy below 400 Hz.

2. Volt-Hertz product not to exceed 2×10^7

3. For inputs above 500V, multiply accuracy by: $\left(\frac{2000V + V\,in}{2000V}\right)$

INSTRUMENT OPERATING CHARACTERISTICS

INPUT CHARACTERISTICS

Range	Full Scale	Resolution		Impedance
		Normal	High	
1V	2.5V	10 uV	1 uV	1 MΩ, <100 pF
10V	20V	100 uV	10 uV	
100V	160V	1 mV	100 uV	
1000V	1000V	10 mV	1 mV	

MAXIMUM INPUT

1000V rms of 2×10^7 volt-hertz product, whichever is less.

TEMPERATURE COEFFICIENT

(0°C to 18°C and 28°C to 50°C)

AC* Only ±(40 ppm or Reading + 20 ppm f.s.)/°C
AC* + DC ±(40 ppm of Reading + 40 ppm f.s.)/°C

**Frequencies <10 kHz*

SETTLING TIME (To within 0.1%)

100 ms, Fast Filter
500 ms, Slow Filter

COMMON MODE REJECTION

(100Ω Unbalance)

120 dB, dc to 60 Hz

CREST FACTOR

>7 at full scale, increasing down scale by:

$$7 \times \sqrt{\frac{V_{Range}}{V_{Input}}}$$

DIGITIZING

Same as dc volts

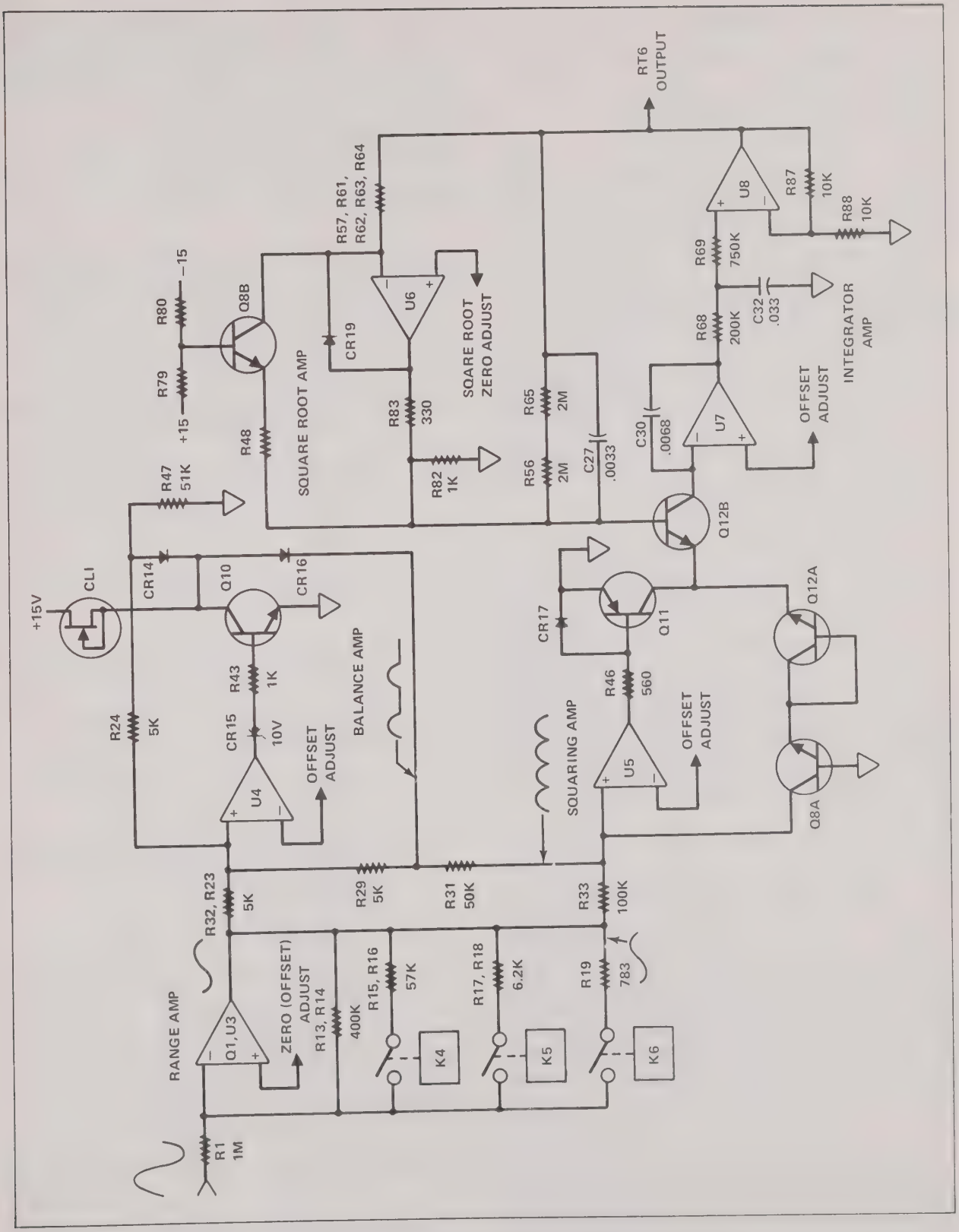


Figure 609A-1. AC/DC Converter (RMS)

609A-12. Circuit Description

609A-13. Refer to the schematic for the following discussion.

609A-14. RANGE AMPLIFIER

609A-15. The Range Amplifier is an inverting amplifier with gain control provided by switching feedback impedances. Feedback impedances are controlled by relays K4, K5, or K6, and consist of parallel resistors and capacitors adjusted for proper gain and frequency response. Relays K1, K2, and K7 control the input to the amplifier. K1 is energized for inputs from the input terminals. K7 is energized for inputs from the Current Shunts module. K2 is energized when selecting ac + dc measurements. Gain of the amplifier is set for a 1V rms output with a full-scale sine wave input with the exception of the 1000V range in which the full-scale output is .8V rms. Q1 and U3 provide the forward gain of the amplifier. CR6, CR7, CR21, and CR22 provide input protection. Q2 drives the guard for the summing node of the operational amplifier.

609A-16. BALANCE AMPLIFIER

609A-17. The Balance Amplifier is an inverting, unity-gain amplifier with diodes in the feedback paths to provide rectification. CL1 and Q10 are configured as a current source driven by U4. A high impedance current source is used to minimize the effects of the diodes on the gain of the amplifier. Due to the unity gain of the inverting amplifier and the ratio of R33 to R31, the negative half-cycles from the Range Amplifier are summed with positive half-cycles having twice the amplitude from the Balance Amplifier. The result is the absolute value of the output from the Range Amplifier. Q6 is used to extend the frequency response of the amplifier.

609A-18. COMPUTATION

609A-19. The Squaring Amplifier, Square Root Amplifier, and Integrator Amplifier work together to perform the rms conversion. This is accomplished by regulating the current in four transistors, Q8A, Q12A, Q8B, and Q12B, matched for temperature coefficient and response characteristics. The Squaring Amplifier sums the outputs from the Range Amplifier and the Balance Amplifier such that the current flowing through its feedback path (Q8A, Q12A) is proportional to the absolute value of the input signal. Forward gain of the amplifier is provided by U5 and Q11 with Q7 extending the frequency response.

609A-20. Q12B is configured such that the integral of its collector current is the output voltage. U7 and U8 integrate the collector current of Q12B. Q8B is configured such that its collector current is proportional to the output voltage. The current through Q8B controls the gain of U6, the Square Root Amplifier, which in turn partially controls the current flowing in Q12B. The integrating time constant of U7 and U8 is determined by R56 and R65 in parallel with C27 or C27 plus C28, depending on which filter is selected from the front panel. The proportionality constant of the converter is such that a full-scale input produces a 20V output on RT6.

609A-21. MAINTENANCE

609A-22. Performance Test

609A-23. Use the following procedure as a performance determination for the AC/DC Converter (RMS). The DC Volts Performance Test given in Section 4 should be done first to ensure proper DC accuracy.

1. Select AC Volts and Autoranging.

2. Connect the AC Calibrator output to the instrument input terminals.

3. Sequentially apply the input voltages and frequencies listed in Table 609A-2, verifying that the instrument reading is within the listed tolerance.

4. Disconnect the AC Calibrator and connect the DC Calibrator.

5. Simultaneously select DC Volts and AC Volts (both indicators illuminated).

6. Select an output from the DC Calibrator of +10.0000 Vdc.

7. The instrument display should be within 9.9840 and 10.0160.

8. Reverse the leads at the output of the DC Calibrator. The display should still read within the limits of Step 8.

Table 609A-2. Performance Test

INPUT		8500A READING	
FREQ	VOLTAGE	LOW	HIGH
10 kHz	1 V	0.99870	1.00130
50 kHz	1 V	0.99450	1.00550
10 kHz	10 V	9.9876	10.0124
50 kHz	10 V	9.9500	10.0500
10 kHz	100 V	99.881	100.119
50 kHz	100 V	99.540	100.460
10 kHz	1000 V	998.48	1001.52

609A-24. Calibration

609A-25. Before calibrating the RMS Converter, perform the DC Calibration procedure in Section 4. Remove the Calibration Memory if installed and allow a one hour warm-up. Allow adequate warm-up time for the Calibrator used, as specified in the Calibrator manual. After calibration is complete, reinstall the Calibration Memory and enter new values at the cardinal points of each range (zero may be entered).

609A-26. Use the following procedure to calibrate the AC/DC Converter (RMS). All adjustments given are on the RMS Converter and are accessible at the top of the module. R66, R55, C24 and R38 are adjustments not accessible from the top of the module which should not require adjustment unless parts have been replaced. Adjustment procedures for these adjustments are given in Troubleshooting in this section of the manual.

609A-27. Range Zero Adjustment is accomplished using the following steps:

1. Select the 10V range.
2. Simultaneously select DC Volts and AC Volts (both indicators illuminated).
3. Connect the test DVM HI to TP5, LO to TP1.
4. Short the input terminals.
5. Adjust R12, RANGE ZERO, for a reading on the test DVM of 0 $\pm$ 30 μV.
6. Remove the input short and the test DVM.

609A-28. Balance Zero Adjustment is accomplished using the following steps:

1. Apply -0.2000000 to the input terminals from the DC Calibrator. Record the reading.
2. Reverse the polarity of the input.
3. Adjust R42, BALANCE ZERO, twice as far as required to reach the reading noted.
4. Reverse polarity again. Readjust R42 until the readings are within 10 μV for either polarity without further adjustment.

609A-29. Balance Gain Adjustment is accomplished using the following steps:

1. Select the Cal mode (CAL switch down, CAL indicator illuminated). Ignore the cal digit for the remainder of this procedure.

NOTE

Entering the cal mode allows over-range inputs without the over-range indication flashing.

2. Apply -20.00000 Vdc to the input from the DC Calibrator. Note the reading.
3. Reverse the polarity.
4. Adjust R32, BALANCE GAIN, to the reading noted.
5. Reverse the polarity again. Readjust R32 until the readings with both polarities are within 10 digits without further adjustment.

609A-30. AC Zero Adjustment is accomplished using the following steps:

1. Select AC Volts, 1V range.
2. Connect the AC Calibrator to the input terminal.
3. Apply 2.5 mV AC, 500 Hz to the input.
4. Adjust R45, AC ZERO, for a reading between 0.00245 and 0.00255.

609A-31. Calibration Adjustments

609A-32. Sequentially apply the input voltages and frequencies listed in Table 609A-3, performing the adjustments as necessary to bring the reading within the stated tolerance. Select AC Volts and manual ranging for these adjustments. If in the first step R64 does not have the required range, perform the coarse calibration in the troubleshooting section. Steps 9 and 24 require a 50Ω termination at the instrument input terminals and the use of four-wire sensing with the AC Calibrator. Two test cables, each with twisted wires, may be used.

609A-33. Troubleshooting

609A-34. Troubleshooting procedures for the AC/DC Converter (RMS) follow the format used in Section 4. Table 609A-4 assures that the problem actually is in the RMS Converter. Figure 609A-2 gives a sympton analysis approach to troubleshooting, with possible failures listed in order of probability, and gives the address and data field used to set up the module. DO NOT remove or install modules with the power on.

609A-35. If Q8 or Q12 are replaced, the module must be returned to the factory (attn: PARTS) for temperature compensation. This is also the only time R38, CREST FACTOR ADJUST, should require readjustment. Do not attempt to adjust R38 as no crest factor generators are commercially available.

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Table 609A-3. Calibration Adjustment

STEP	RANGE	INPUT		ADJUST/ CHECK	TOLERANCE	
		VOLTAGE	FREQUENCY		LOW	HIGH
1	1000V	500V[1]	500 Hz	R64	499.90	500.10
2	1000V	500V[1]	50 kHz	C4	499.80	500.20
3	1000V	1000V[1]	10 kHz	Wait 30 sec. Check	999.20	1000.80
4	1V	2.5V	500 Hz	R14	2.49975	2.50025
5	1V	2.5V	50 kHz	C9	2.49900	2.50100
6	10V	20V	500 Hz	R16	19.9980	20.0020
7	10V	20V	50 kHz	C11	19.9900	20.0100
8	10V	10V	1 MHz	Check (R75)[2]	9.8000	0.2000
9	1V	1V	1 MHz[3]	Check (R75)[2]	0.9800	1.02000
10	1V	2.5V	300 kHz	Check	2.48000	2.52000
11	1V	2.5V	20 kHz	Check	2.49900	2.50100
12	1V	2.5V	50 Hz[4]	Check	2.49900	2.50100
13	1V	2.5V	100 kHz	Check	2.49900	2.51000
14	1V	.25V	100 kHz	Check	0.24600	0.25400
15	1V	2.5 mV	50 kHz	Check	0.00150	0.00350
16	1V	2.5 mV	500 Hz	Check	0.00230	0.00270
17	1V	.8V	500 Hz	Check	0.79960	0.80040
18	100V	160V[1]	500 Hz	R18	159.960	160.020
19	100V	160V[1]	50 kHz	C14	159.960	160.040
20	100V	67V	300 kHz	Check	66.800	68.200
21	10V	20V	300 kHz	Check	19.7500	20.2500
22	1V	.8V	300 kHz	Check	0.78500	0.81500
23	1V	.2V	300 kHz	Check	0.18800	0.21200
24	1V	.1V	1 MHz[3]	Check	0.07000	0.13000

1. Use CAUTION, Dangerous voltage.
2. If R75 is adjusted, repeat the previous steps.
3. Terminate cable in 50Ω; use four-wire sense on Calibrator as explained in the text.
4. FILTER must be ON.

Table 609-4. AC Converter Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do the DC Performance Test (Section4).		Section
2	Is DC Volts within tolerance?	3	4
3	Is the Calibration Memory module installed?	4	6
4	Remove the Calibration Memory module. Is AC OK?	5	6
5	Bad Calibration Memory. Go to Section 604.		
6	Is Isolator installed?	7	10
7	Replace Isolator with Bus Interconnect/Monitor pcb.		
8	Is AC OK?	9	10
9	Bad Isolator. Go to Section 608.		
10	Remove DC Signal Conditioner. Is AC OK?	11	12
11	DC Signal Conditioner interfering with AC. The problem in the DC Signal Conditioner is one of the following: 1. Digital Logic Bad, 2. K1 or K2 shorted, 3. Q6, Q7, Q8 Bad.		
12	Install Bus Interconnect/Monitor if not already installed.		
13	Check power supply voltages as follows: VA1 = +14.24 to 15.75V VA4 = −29 to −32V VA2 = −14.25 to −15.75V Vcc = −15V Difference =4.9 VA3 = +29 to 32V Vss = −20V to 5.2		
14	Are the supply voltages OK?	15	Section 4
15	Go to Figure 609-2.		

SYMPTOM	POSSIBLE FAILURE
High reading on display with open inputs, 1000V range	C24 misadjusted, Q9, Q10, U4
High frequency (300 kHz) bad	C24 misadjusted or bad, U3
Reading not stable	U3, U4
Crest factor bad	Q8, Q12
AC breaks down (overload source above 500V)	K7
AC out of tolerance in slow filter mode	Q13 and Q14, Q16 and Q17
One range bad	Digital Logic Range Relays, CR14, CR16
All ranges bad	U3, Q1, U5, Q7, U7, U8, K8, K1
Excessive noise	U3, Q2
Display blanks	U1, U10

The largest single failure items tend to be relays and electrolytic capacitors

Note: If Q8 or Q12 is replaced, the module should be returned to the factory (Attn. Parts) for temperature compensation and adjustment of R38.

Address IC 0, 2, 4 high

IDO =0, ID1 = 0 —DC Coupled AC
IDO = 1, ID1 =0 —AC Volts
DIO = 0, ID1 = 1 —RT1 input for AC Current
ID2 =0 —Filter On
ID3 =0 —10V range
ID4 =0 —100V range
ID5 =0 —1000V range
ID3 through ID5 = 1—1V range

Figure 609-2. Symptom Analysis

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8500 Series

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35A Preliminary Cal

609A-36. If other parts are replaced, it may be necessary to make the following adjustments before continuing with the calibration procedure. To assure proper functioning of the module the following procedure should be completed. Many of the adjustments must be performed again in the final calibration procedure. Always perform final calibration from the beginning of the procedure. Select the cal mode by placing the CAL switch in the down position. Ignore the cal digit for this procedure. Some of these adjustments are not accessible from the top of the module. Center all adjustments before beginning calibration except for R38, C24, and R64. R64 should be set fully counterclockwise. R38 should NOT be changed.

CAUTION

When high voltages are applied to the input terminals and the module is not enclosed in the case, hazardous voltages are present on the board. Use an insulated tool for making adjustments while keeping hands away from the PCB.

1. Select AC Volts and the 1V range (manually) and short the input terminals.
2. Short TP3 and TP4 to the metal divider on the board.
3. Connect the test DVM HI to TP2 and LO to TP1.
4. Adjust R66, INTEGRATOR ZERO, for 0V ±100 μV.
5. Remove the short from TP3.
6. Add a jumper from the bottom of R57 (junction with R61) to a jumper added across R48.
7. Connect the test DVM HI to TP3.
8. Adjust R55, SQUARE ROOT ZERO, for OV ±100 μV.
9. Remove the short from TP4 and the jumper from R48.
10. Simultaneously select AC Volts and DC Volts; manually select the 10V range.
11. Connect the test DVM HI to TP5.
12. Adjust R12. RANGE ZERO, for 0V ± 30 μV.
13. Disconnect the test DVM and remove the short from the input terminals.
14. Center R45, AC ZERO, and apply -0.2V from the DC Calibrator to the input terminals. Note the reading on the display.
15. Reverse the polarity of the input and adjust R42, BALANCE ZERO, twice as far as required to reach the reading noted.
16. Reverse the polarity again and readjust R42 until the readings obtained with both polarities are within 10 digits without further adjustment.
17. Apply -20V DC to the input and note the reading.
18. Reverse the input polarity and adjust R32, BALANCE GAIN, for the same reading as noted in the last step ±5 digits.
19. Apply -0.02V DC and adjust R45, AC Zero, for a reading of 0.0200 ±5 digits.
20. Disconnect the DC Calibrator and connect the AC Calibrator.
21. Select AC Volts and the 1000V range.
22. Set R64 fully counterclockwise.
23. Apply 500V @ 500 Hz to the input from the AC Calibrator.
24. Note the reading and clip links according to Table 609A-5. Link 1 is across R61, link 2 is across R62, and link 3 is across R63.
25. Adjust R64, 1000V LOW FREQ, ADJUST, for a reading of 500.000V ±20 digits.
26. Change the frequency to 50 kHz and adjust C4, 1000V HIGH FREQ ADJUST, for 500.000V ±20 digits.
27. Apply 2.5V @ 500 Hz to the input and manually select the 1V range.
28. Adjust R14, 1V LF, for 2.50000 ±10 digits.
29. Change the input frequency to 50 kHz and adjust C9, 1V HF-1, for 2.50000 ±100 digits.
30. Change the input frequency to 500 kHz and adjust C24, 1V HF-2, to bring the reading toward 2.5V. Adjusting C24 will require re-adjusting C9. Alternately adjust C9 as in step 29, than C24 @ 500 kHz until a reading of 2.50000V ±3000 digits is obtained.

NOTE

C9 has approximately twice the effect at 500 kHz as at 50 kHz. If C24 hasn't enough range, adjust R75, 1 MHz. Turn it CW to raise the reading or CCW to lower the reading (½ turn is about 3000 digits).

31. Check the stability by selecting the 1000V range and applying 1000V @ 10 kHz. The reading should be 1000.00 ±80 digits. Wait thirty seconds. If the reading is out of tolerance, with caution and an insulated tool, adjust C24 slightly beyond the point where a stable reading is displayed. Recheck steps 29 and 30.

32. Apply 20V @ 500 Hz and select the 10V range.

33. Adjust R16, 10V LF, for a reading of 20.0000 ±20 digits.

34. Change the frequency to 50 kHz and adjust C11, 10V HF, for 20.0000 ±100 digits.

35. Apply 10V @ 1 MHz using four-wire sensing (without the 50Ω termination).

36. Adjust R75, 1 MHz, for a reading of 10.0000 ±100 digits.

37. Apply 1V @ 1 MHz using four-wire sensing with the 50Ω termination at the input terminals. Manually select the 1V range.

38. Initially note the reading without adjusting R75. If this reading is not 1.00000V ±.036V, adjust C24 until the reading is within ±.036V and note this reading. Adjust R75 until the reading is halfway between the noted reading and 1.00000V. This final reading, then, should be 1.00000V ±.018V.

39. Apply 500V @ 50 kHz. The reading should be 500.00 ±20 digits (adjust C4 if necessary).

40. Apply 2.5V @ 500 kHz and check reading for 2.50000 ±.03V. Adjust C24 if necessary to bring the reading within the specification.

41. If C24 was adjusted in Step 40, check the stability by applying 1000V @ 10 kHz. The reading should be stable at 1000.00 ±.8V. Re-adjust C24 and repeat Step 40 if the reading is unstable.

42. Apply 2.5V @ 50 kHz. Adjust C9 if necessary for a reading of 2.50000 ±.001V.

43. Apply 20V @ 50 kHz and adjust C11 if necessary for a reading of 20.0000 ±.01V.

44. Apply 10V @ 1 MHz using a four-wire cable. The reading should be 10.0000 ±.02V.

45. Apply 1V @ 1 MHz using a four-wire cable with a 50Ω termination. The reading should be 1.00000 ±.02V.

46. If Steps 44 or 45 are out of tolerance repeat Steps 36 through 45.

47. Select the 100V range and apply 160V @ 500 Hz. Verify that R18, 100V LF, will adjust the reading to 160.000V ± 50 digits.

48. Check the output ripple by turning the filter off and applying 2.5V @ 200 Hz from a lab oscillator on the 1V range and adjust the oscillator output for a reading of 2.50000V ± 1000 digits. Connect the oscilloscope HI to TP2, LO to shield. The ripple should be less than 20 mV P-P.

49. Change the frequency to 20 Hz and turn the filter on. Readjust the voltage as in step 44 The ripple should be less than 80 mV P-P.

50. Perform the Calibration procedure (Paragraph 609A-24).

Table 609A-5. High Voltage, Low Frequency Coarse Adjust

Reading	Links Previously Clipped	Clip Links	Replace Links
500 - 495.5 N/A (Pot R64 should adjust properly)		None	None
495.5 - 491.1	1	2	1
	2	1	None
	1 & 2	3	1 & 2
	3	1	None
	1 & 3	2	1
	2 & 3	1	None
500 - 504.5	1	None	1
	2	1	2
	1 & 2	None	1
	3	1 & 2	3
	1 & 3	None	1
	2 & 3	1	3
	1, 2, & 3	None	1

609A-37. PARTS LIST

609A-38. Table 609A-6 gives a parts breakdown for the AC/DC Converter (RMS). Refer to Section 5 for ordering information.

⊗CAUTION

Indicated devices are subject to damage by static discharge.

Table 609A-6. RMS Converter Assembly

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	RMS CONVERTER ASSEMBLY (MIS–4103) Figure: 609A–3	383935	89536	383935			
C1	Cap, mylar, 0.22 μF ±20%, 1200V	268904	84411	JF-65	1		
C2	Cap, porc 1.5 pF ±0.25 pF, 1.7V ACK	461004	95275	VY10CA1R5CA	1		
C3	Cap, mica, 220 pF ±5%, 500V	170423	72136	DM15F221J	1		
C4	Cap, var, 0.25–1.5 pF, 2000V	218206	72982	530-000	2	1	
C7	Cap, mylar, 0.10 μF ± 10%, 100V	393439	73445	C280MAH/A100K	3		
C8	Cap, porc, 5.6 pF ±0.25 pF, 1000V	460568	95275	VY10CA5R6CA	1		
C9	Cap, var, 0.25–1.5 pF, 2000V	218206	72982	530-000	REF		
C10	Cap, mica, 43 pF ±1%, 500V	277202	72136	DM15E430F	1		
C11	Cap, var, 0.8–10.0 pF, 250V	229930	91293	JMC2951	1	1	
C12	Cap, poly film, 0.047 μF ±10%, 250V	162008	73445	C280MAE/A47K	1		
C13	Cap, mica, 390 pF ±1%, 500V	355339	72136	DM15F391F	1		
C14	Cap, var, 9-35 pF, 350V	289637	72982	538-006D9-35	1	1	
C15	Cap, mica, 3600 pF ±2%, 500V	176644	72136	DM19F362G	1		
C16	Cap, mica, 27 pF ±5%, 500V	177998	72136	DM15F270J	6		
C17	Cap, mica, 8 pF ±10%, 500V	216986	72136	DM15C080K	1		
C18	Cap, mica, 27 pF ±5%, 500V	177998	72136	DM15F270J	REF		
C19	Cap, mica 1000 pF ±5%, 500V	148387	72136	DM19F102J	2		
C20	Cap, mica, 27 pF ±5%, 500V	177998	72136	DM15F270J	REF		
C21	Cap, mica, 2 pF ±0.5 pF, 500V	175208	72136	DM15C020E	1		
C22	Cap, mica, 1000 pF ±5%, 500V	148387	72136	DM19F102J	REF		
C23	Cap, Ta, elect, 15 μF ±10%, 20V	153056	56289	150D156X-9020B2	3	1	
C24	Cap, var, 1.7–10 pF, 250V	321109	56289	GKB10000	1	1	
C25	Cap, mica, 390 pF ±5%, 500V	148437	72136	DM15F391J	1		
C26	Cap, mica, 27 pF ±5%, 500V	177998	72136	DM15F270J	1		
C27	Cap, mylar, 0.0033 μF ±10%, 50V	402867	06001	75F1R5A-333	2		
C28	Cap, poly film, 0.01 μF ±10%, 400V	402818	73445	C280MAF/A10K	1		
C29	Cap, mylar, 0.022 μF ±10%, 250V	234484	73445	C280MAE/A22K	2		
C30	Cap, mylar, 0.0068 μF ±20%, 200V	106070	56289	192P68202	1		
C31	Cap, mica, 27 pF ±5%, 500V	177998	72136	DM15F270J	REF		
C32	Cap, mylar, 0.033 μF ±10%, 250V	234492	73445	C280MAE/A33K	2		
C33	Cap, mylar, 0.0047 μF ±10%, 50V	260844	06001	75F1R5A347	1		
C34	Cap, mylar, 0.10 μF ±10%, 100V	393439	73445	C280AH/A100K	REF		

CHECK ERRATA

CHANGE #28

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
C35	Cap, mylar, 0.033 μF ±10%, 250V	234492	73445	C280MAE/A33K	REF		
C36, C37	Cap, Ta, elect, 15 μF ±10%, 20V	153056	56289	150D156X-9020B2	REF		
C38	Cap, mica, 4 pF ±0.5%, 500V	190397	72136	DM15C040E	2		
C39	Cap, mylar 0.10 μF ±10%, 100V	393439	73445	C280MAH/A100K	REF		
C40	Cap, mica, 15 pF ±5%, 500V	148569	72136	DM15C150J	2		
C41	Cap, mylar, 0.022 μF ±10%, 250V	234484	73445	C280MAE/A22K	REF		
C42	Cap, mylar, 0.0033 μF ±10%, 50V	402876	06001	75F1R5A333	REF		
C43	Cap, Ta, 6.8 μF ±20%, 35V	363713	56289	196D685X-0035HA1	1		
C44	Cap, mica, 4 pF ±0.5%, 500V	190397	72136	DM15C040E	REF		
C45	Cap, mica, 27 pF ±5%, 500V	177998	72136	DM15F270J	REF		
C46	Cap, mica, 15 pF ±5%, 500V	148569	72136	DM15C150J	REF		
C47	Cap, mylar, 0.001 μF ±10%, 200V	159582	56289	192P10292	1		
CL1	Diode, FET, current regulator	285106	07910	TCR5309	1		
CR2 thru CR5	Diode, Si, hi-speed switch	203323	07910	1N4448	8	2	
CR6, CR7	Diode, Si lo-cap, lo-leakage	375907	07263	FD7222	4	1	
CR8, CR9 CR10	Diode, Si, hi-speed switch	203323	07910	1N4448	REF		
CR11	Diode, zener	246611	07910	1N961B	4	1	
CR14	Diode, Si sm sig	313247	28480	HP5082-6264	2	1	
CR15	Diode, zener	246611	07910	1N961B	REF		
CR16	Diode, Si, sm sig	313247	28480	HP5082-6264	REF		
CR17	Diode, Si, hi-speed switch	203323	07910	1N4448	REF		
CR18	Diode, zener	246611	07910	1N961B	REF		
CR19	Diode, Si, rect, lo-vol, lo-leak	180594	07910	TD12599	1	1	
CR21, CR22	Diode, zener	260695	07910	1N754A	2	1	
CR24	Diode, zener	246611	07910	1N961B	REF		
K1	Coil, reed relay	272070	71707	UD-6-P	2		
K2	Coil, reed relay	269019	71707	U-6-P	1		
K4, K5, K6	Relay, dry reed	357566	71707	UF40069	4		
K7	Coil, reed relay	272070	71707	UD-6-P	REF		
K8	Relay, dry reed	357566	71707	UF40069	REF		

CHECK ERRATA

CHANGE # 33

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q1	Xstr, FET, dual, N-channel	267963	89536	267963	1	1	
Q2	Xstr, FET, N-channel	343103	89536	343103	3	1	
Q4	Xstr, Si, NPN	218396	04713	2N3904	4	1	
Q6, Q7	Xstr, FET, N-channel	343103	89536	343103	REF		
Q8, Q12	Xstr, matched set	341057	89536	341057	1	1	
Q10	Xstr, Si, NPN	218396	04713	2N3904	REF		
Q11	Xstr, Si, PNP	195974	04713	2N3906	1	1	
Q13	Xstr, FET, N-channel	288324	89536	288324	3	1	
Q14	Xstr, FET, N-channel	393314	89536	393314	1	1	
Q15	Xstr, Si, PNP	218388	07236	2N3645	1	1	
Q16, Q17	Xstr, FET, N-channel	288324	89536	288324	REF		
Q18, Q19	Xstr, Si, NPN	218396	04713	2N3904	REF		
Q20	Xstr, Si, PNP	226290	04713	MPS3640	1	1	
R1	Res, mtl film, 1M ±0.1%, 1W	340265	03888	PME75	1		
R2	Res, mtl film, 13k ±1%, 1/8W	335539	91637	CMF551302F	1		
R3	Res, mtl film, 2k ±1%, 1/8W	235226	91637	CMF552001F	1		
R6, R7	Res, mtl film, 50k ±0.1%, 1/8W	340257	91637	CMF555002B	3		
R9	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	6		
R10	Res, comp, 470 ±5%, 1/4W	147983	01121	CB4715	1		
R11	Res, comp, 12k ±5%, 1/4W	159731	01121	CB1235	1		
R12	Res, var, cermet, 1M ±10%, 1/2W	334722	89536	334722	3	1	
R13	Res, mtl film, 399.0k ±0.1%, 1/8W	417212	91637	CMF553993B	1		
R14	Res, var, cermet, 2k ±10%, 1/2W	285163	89536	285163	1	1	
R15	Res, mtl film, 56.89k ±0.1%, 1/8W	417220	91637	CMF5556891B	1		
R16	Res, var, cermet, 500 ±10%, 1/2W	291120	89536	291120	1	1	
R17	Res, mtl film, 6324 ±0.1%, 1/8W	417238	91637	CMF556324B	1		
R18	Res, var, cermet, 50 ±10%, 1/2W	285122	89536	285122	2	1	
R19	Res, mtl film, 782.8 ±0.1%, 1/8W	417246	91637	CMF55782R8B	1		
R20	Res, comp, 4.7k ±5%, 1/4W	148072	01121	CB4725	2		
R21	Res, comp, 100 ±5%, 1/4W	147926	01121	CB1015	1		
R22	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	1		
R23	Res, mtl film, 4.975 ±0.1%, 1/8W	340232	91637	CMF554975B	1		
R24	Res, comp, 5.1k ±5%, 1/4W	193342	01121	CB5125	1		
R25	Res, comp, 3k ±5%, 1/4W	193508	01121	CB3025	1		
R26	Res, comp, 3.9k ±5%, 1/4W	148064	01121	CB3925	1		

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R27	Res, mtl film, 1M ±1%, 1/8W	268797	91637	CMF551004F	2		
R28	Res, mtl film, 121 ±1%, 1/8W	343160	91637	CMF551210F	1		
R29	Res, mtl film, 5k ±0.1%, 1/8W	340240	91637	CMF555001B	1		
R30	Res, comp, 5.6k ±5%, 1/4W	148080	01121	CB5625	3		
R31	Res, mtl film, 50k ±0.1%, 1/8W	340257	91637	CMF555002B	REF		
R32	Res, var, cermet, 50 ±10%, 1/2W	285122	89536	285122	REF		
R33	Res, mtl film, 100k ±0.1%, 1/8W	340166	91637	CMF551003B	1		
R34	Res, mtl film, 35.7k ±1%, 1/8W	288480	91637	CMF553572F	1		
R35	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	REF		
R36	Res, comp, 82 ±5%, 1/4W	149484	01121	CB8205	1		
R37	Res, comp, 5.6k ±5%, 1/4W	148080	01121	CB5625	REF		
R38	Res, var, cermet, 3 ±25%, 1/2W	347963	32997	3329H-J81-3R0	1		
R40	Res, comp, 5.6k ±5%, 1/4W	148080	01121	CB5625	REF		
R42	Res, var, cermet, 1M ±10%, 1/2W	334722	89536	334722	1		
R43	Res, comp, 1k ±5%, 1/4W	148023	01121	CB1025	2		
R44	Res, comp, 9.1k ±5%, 1/4W	193318	01121	CB9125	1		
R45	Res, var, cermet, 1M ±10%, 1/2W	334722	89536	334722	REF		
R46	Res, comp, 560 ±5%, 1/4W	147991	01121	CB5615	3		
R47	Res, comp, 51k ±5%, 1/4W	193334	01121	CB5135	1		
R49	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	2		
R50	Res, comp, 22 ±5%, 1/4W	147884	01121	CB2205	1		
R51	Res, comp, 47k ±5%, 1/4W	148163	01121	CB4735	1		
R52	Res, mtl film, 4.02M ±1%, 1/4W	417253	91637	CMF604024F	1		
R53	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	REF		
R54	Res, comp, 560 ±5%, 1/4W	147991	01121	CB5615	REF		
R55	Res, var, cermet, 1M ±10%, 1/2W	276691	89536	276691	2		
R56	Res, mtl film, 2M ±0.25%, 1/2W	327502	91637	CMF652004C	2		
R57	Res, mtl film, 930k ±0.25%, 1/4W	417345	91637	CMF609303C	1		
R58	Res, mtl film, 1M ±1%, 1/8W	268797	91637	CMF551004F	REF		
R59	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	REF		
R60	Res, comp, 560 ±5%, 1/4W	147991	01121	CB5615	REF		
R61	Res, mtl film, 17.4k ±1%, 1/8W	236802	91637	CMF551742F	1		
R62	Res, mtl film, 34k ±1%, 1/8W	261602	91637	CMF553402F	1		
R63	Res, mtl film, 68.1k ±1%, 1/8W	236828	91637	CMF556812F	1		

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R64	Res, var, cermet, 20k ±10%, 1/2W	291609	89536	291609	1	1	
R65	Res, mtl film, 2M ±0.25%, 1/2W	327502	91637	CMF652004C	REF		
R66	Res, var, cermet, 1M ±10%, 1/2W	276691	89536	276691	REF		
R67	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	REF		
R68	Res, comp, 200k ±5%, 1/4W	248781	01121	CB2045	1		
R69	Res, comp, 750k ±5%, 1/4W	221937	01121	CB7545	1		
R70	Res, comp, 1M ±5%, 1/4W	182204	01121	CB1055	REF		
R71	Res, comp, 470k ±5%, 1/4W	188411	01121	CB4745	1		
R72	Res, comp, 22k ±5%, 1/4W	148130	01121	CB2235	1		
R73	Res, comp, 100k ±5%, 1/4W	148189	01121	CB1045	1		
R74	Res, comp, 20k ±5%, 1/4W	221614	01121	CB2035	2		
R75	Res, var, cermet, 10k ±10%, 1/2W	285171	89536	285171	1		
R76	Res, comp, 1k ±5%, 1/4W	148023	01121	CB1025	REF		
R77	Res, mtl, film, 23.2k ±1%, 1/8W	291351	91637	CMF552322	1		
R78	Res, mtl film, 10 ±1%, 1/8W	268789	91637	CMF55A100F	1		
R81	Res, thermistor, temp sensitive	104596	73168	JA41J1	1		
R82	Res, comp, 1k ±5%, 1/4W	148023	01121	CB1025	REF		
R83	Res, comp, 330 ±5%, 1/4W	147967	01121	CB3315	REF		
R84	Res, comp, 4.7k ±5%, 1/4W	148072	01121	CB4725	REF		
R85	Res, comp, 20k ±5%, 1/4W	221614	01121	CB2035	REF		
R86	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	2		
R87, R88	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	3		
R89	Res, mtl film, 42.2k ±1%, 1/8W	221655	91637	CMF554222F	1		
R90	Res, comp, 150 ±5%, 1/4W	147934	01121	CB1515	REF		
R92	Res, comp, 10k ±5%, 1/4W	148106	01121	CB1035	REF		
U1	IC, C-MOS, NAND gates	375147	02735	CD4023AE	1	1	
U2	IC, ttl, hex inverter, buffer/driver	288605	01295	SN7416N	1	1	
U3	IC, lin, op amp	329912	12040	LM318H	1	1	
U4	IC, op amp	225961	24355	AD3092	1	1	
U5	IC, lin, op amp	288928	12040	LM308AH	1	1	
U6, U7	IC, lin, op amp	284760	12040	LM308H	2	1	
U8	IC, lin, op amp	381889	12040	LM201AH	1	1	
U9	IC, C-MOS, hex buffer/inverter	381848	20735	CD4049AE	1	1	

Table 609A-6. RMS Converter Assembly (cont)

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
U10	IC, C-MOS, hex D F-F	404509	12040	MM74C174N	1	1	
XK1, XK7	Switch, dry reed	219097	95348	MR5972	2		
XK1, XK2, XK7	Switch, dry reed	284091	95348	MR138	3		
XK1, XK2, XK7	Foil wrap	313833	89536	313833	5		
XQ15	Transipad	152207	07047	10123DAP	1		
	Feed-thru, teflon	281865	12615	SL-841-777	4		
	Hardware:						
	Screw	256164	89536	256164	1		
	Heatsink	347740	05820	260-18D	1		
	Shield, input	468470	89536	468470	1		
	Socket	343285	00779	2-331272-6	5		
	Spring	424465	83553	C0120-014-0380	1		
	Stand-off, teflon	275719	15849	1497B	5		
	Transipad	175125	89536	175125	1		

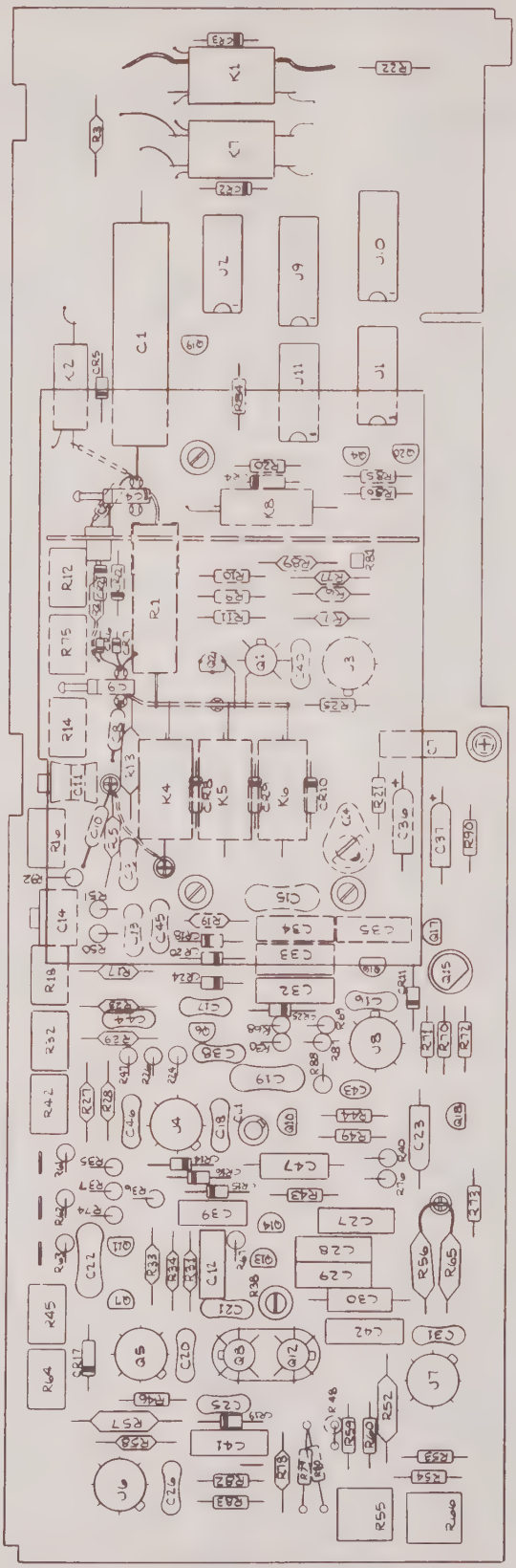

Figure 609A-3. RMS Converter PCB Assembly (Sheet 1 of 2) (MIS-1703)

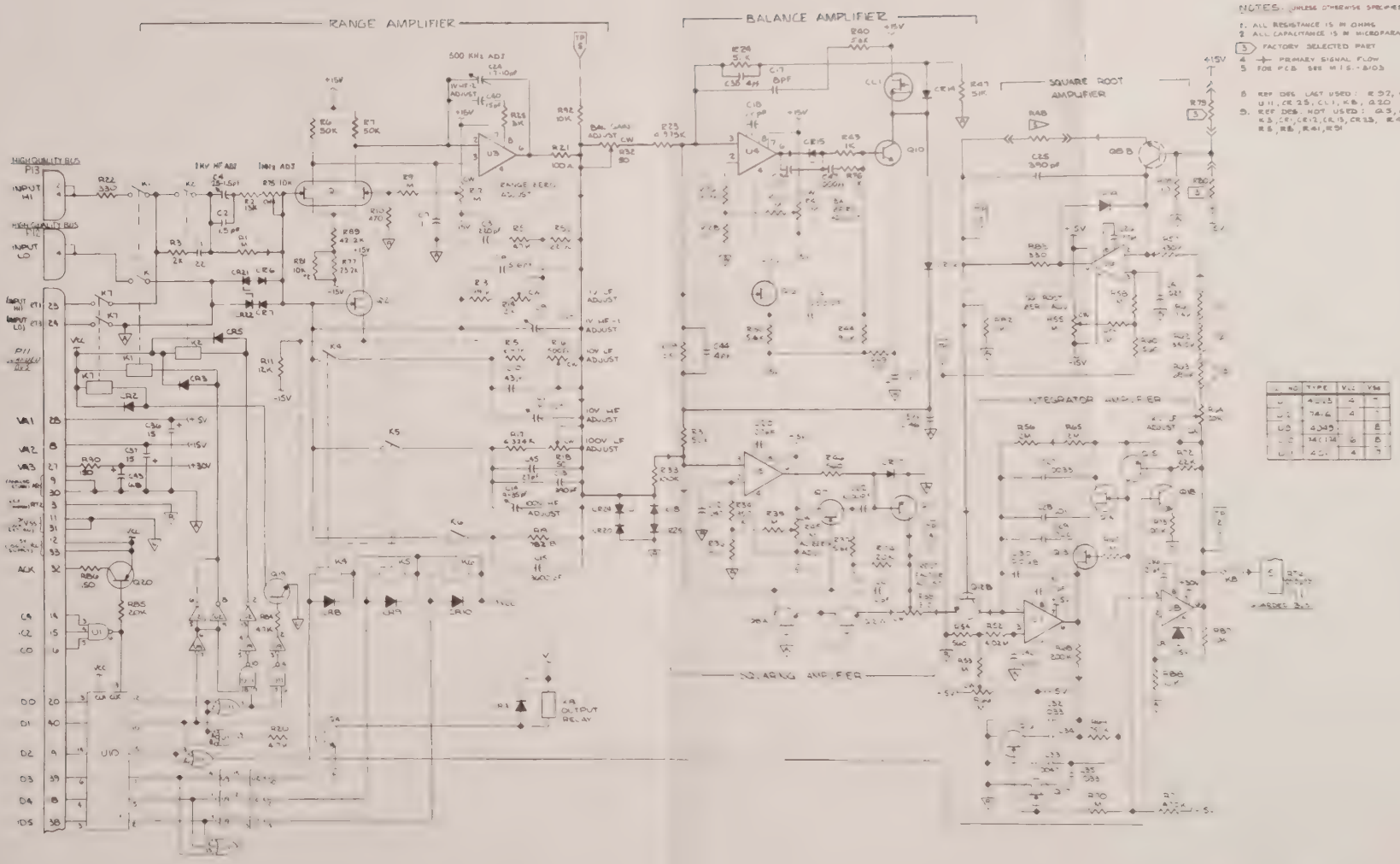
CHANGE # 33
NOTES: (UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTANCE IS IN OHMS
2. ALL CAPACITANCE IS IN MICROFARADS
3. FACTORY SELECTED PART
4. PRIMARY SIGNAL FLOW
5. FOR PCB SEE MIS-8103
6. REF DES LAST USED: R 32, C47, U 11, CR 28, Q 11, K6, Q 30
9. REF DES NOT USED: Q 3, Q 9, K 3, CR1, CR 2, CR 13, CR 23, R 4, R 5, R 6, R 61, R 91
RANGE AMPLIFIER
BALANCE AMPLIFIER
SQUARE ROOT AMPLIFIER
INTEGRATOR AMPLIFIER
SCALING AMPLIFIER
500 KHz ADJ
1KV HF ADJ
100V HF ADJ
1V LF ADJUST
1V HF -1 ADJUST
10V LF ADJUST
10V HF ADJUST
100V LF ADJUST
100V HF ADJUST
HIGH QUALITY BUS
INPUT HI
INPUT LO
RANGE RELAYS
OUTPUT RELAY
U NO.
TYPE
VCC
VEE

Figure 609A-3. RMS Converter PCB Assembly (Sheet 2 of 2) (MIS-1103)

Option —17
Rear Input

617-1. INTRODUCTION

617-2. Installation of the Rear Input option allows single-connector access to the Input Sense and Source terminals, the Guard terminal, and the ohms guard for ease in systems type measurements. Refer to Section 602 for use of the ohms guard. All connections are directly to the High-Quality Bus. For an explanation of the bus structure, refer to Section 3. When making connections through the Rear Input connector, the shorting links should be removed from the front panel input terminals. Guard connections explained in Section 2 then must be made through the Rear Input.

617-3. INSTALLATION

617-4. To install the Rear Input option use the following procedure. Figure 617-1 illustrates proper installation. Table 617-1 lists the pin identification and associated signal line. Pin D of the cable connector should be connected to the metal shield or hood over the connector so that all metal surfaces will be grounded.

1. Remove the top cover from the instrument.

2. Remove the cover plate from the rear input entry port.

3. Install the rear input cable connector in the entry port using the screws that held the cover plate in place.

4. Attach the ground wire (grn/yel) to the chassis through the existing hole. Use the #4-40 screw and nut included in the kit.

5. Plug the pcb connector into the card edge connector located on the right side of the mother-board between the 4th (A/D Converter) and 5th (Isolator) module positions, from the rear panel.

6. Replace the top cover on the instrument.

Table 617-1. Rear Input Connections

PIN	SIGNAL
A	Guard
B	Source Lo
D	Chassis
E	Input Lo
K	Ext Ref Hi
L	Ext Ref Lo
R	Ohms Source Guard
S	Input Hi
X	Source Hi

617-5. MAINTENANCE

617-6. Fuse F1 is mounted on the same plate as the Rear Input Connector. It is the current overload protection in series with the Source HI terminal. Use a 1½A fast-blow fuse as a replacement.

617-7. The plate on which the connector is mounted is made of a special high-resistance, low-leakage material to minimize leakage error in high-resistance measurements. If leakage is suspected, clean the plate with a mild detergent. Rinse well with hot water.

617-8. PARTS LIST

617-9. Table 617-2 gives a parts breakdown for the Rear Input assembly. Refer to Section 5 for ordering information.

CHECK ERRATA #7

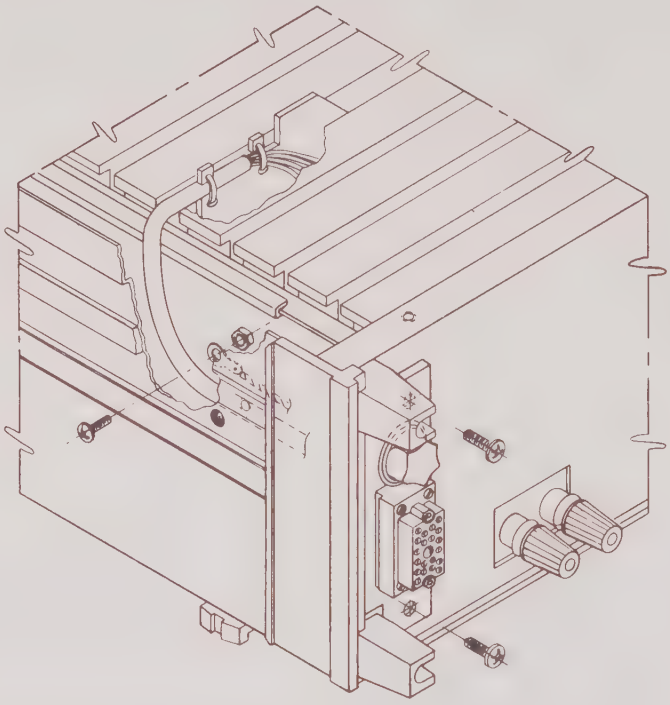

Figure 617-1. Rear Input Option –17 Installation

Table 617-2. Harness Rear Input Assembly PCB

REF DESIG OR ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG FED SPLY CDE	MFG PART. NO. OR TYPE	TOT QTY	REC QTY	USE CDE
	HARNESS REAR INPUT ASSEMBLY PCB 8500A-4414 Figure: 617-3						
F1	Fuse, fast acting 1-1/2 Amp	109330	71400	AGC 1-1/2	1	5	
F2	Wire, magnet, #36	160978	70903	36	.01 lb.		
RL1	Res coil assembly	438325	89536	438325	1		
R1, R2	Res, mtl film	247569	91637	MFF1-23092F	2		
R3	Res, comp, 300 ±5%, 1/4W	348276	01121	CB3015	1		
XF1	Fuseholder	435628	Schurter	031.2009	1		
1	Cable	420851	89536	420851	1		
2	Clamp, cable, nylon	103796	95987	5/16-3NA	1		
3	Nut, hex double chamfer	110668	73734	8000-NP	4		
4	Nut	281113	89536	281113	1		
5	Screw, FH, 2-56 x 5/8	370270	89536	370270	4		
6	Screw, PHP, 8-32 x 1/4	228890	73734	19062	1		
7	Washer, lock, int tooth	110676	73734	99400	4		

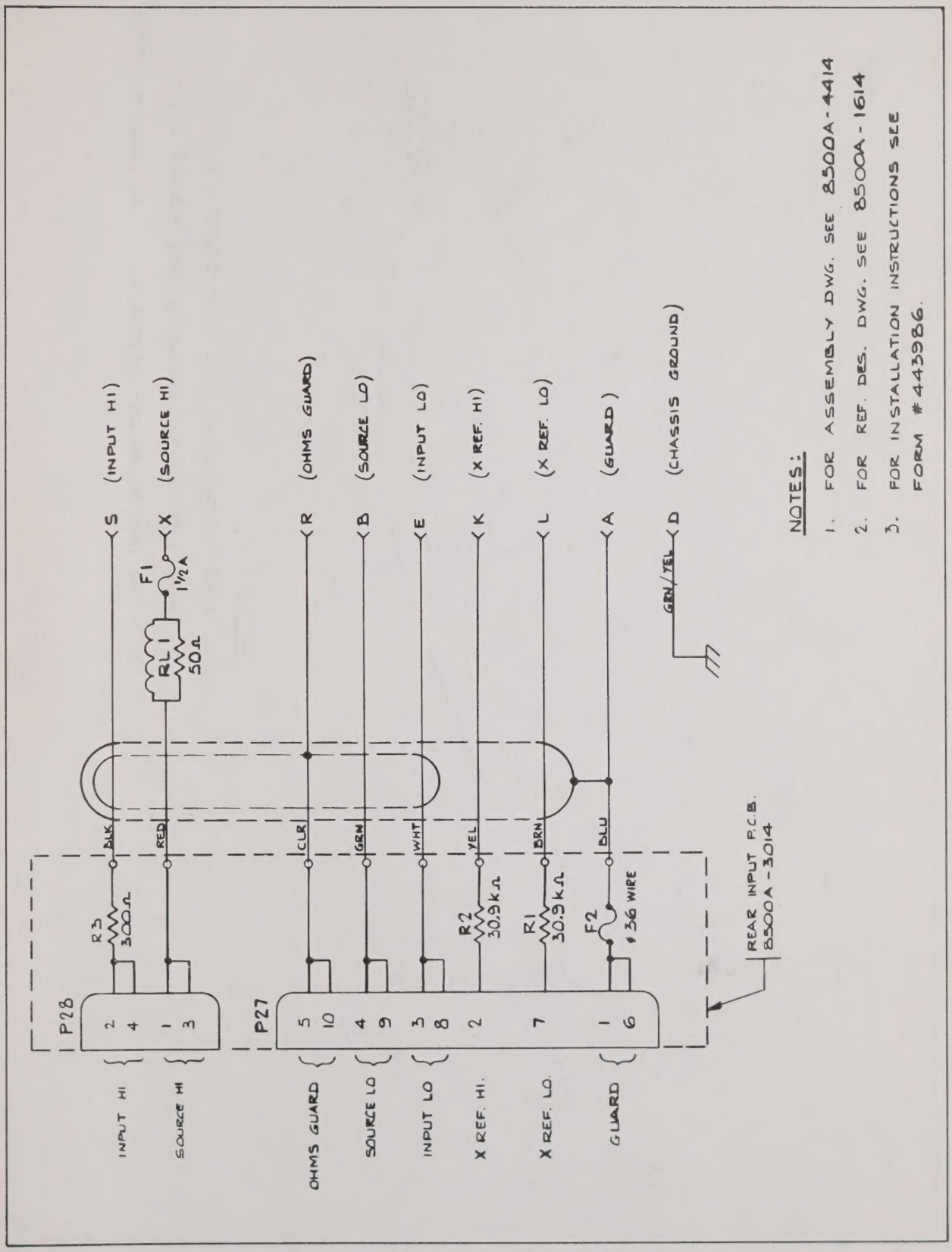

Figure 617-2. Interconnect, Rear Input (8500A-1314)

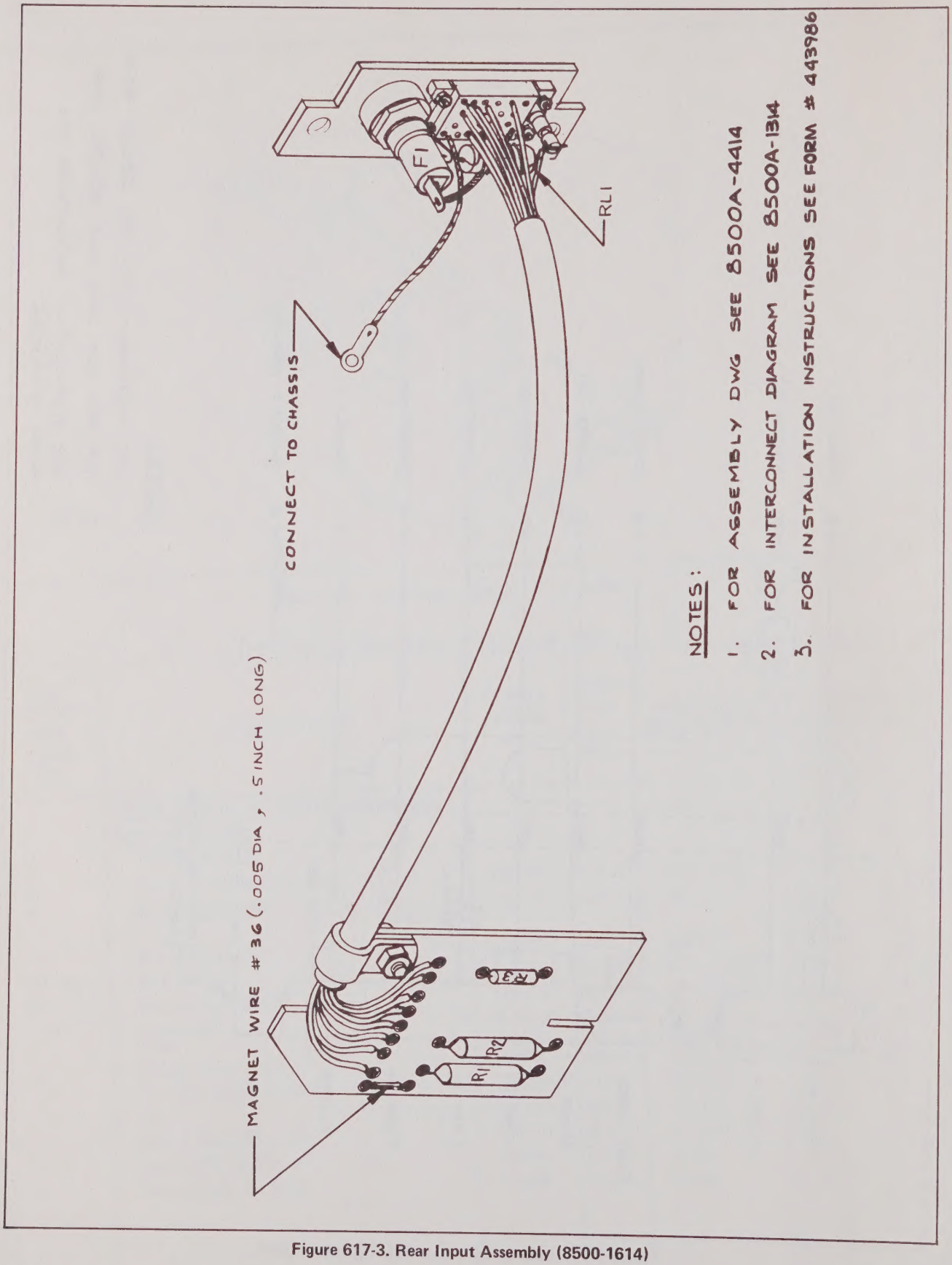

Figure 617-3. Rear Input Assembly (8500-1614)